Smithsonian

April 1986

Woman Eating Plums
is a new twist in
chair design (p. 96)

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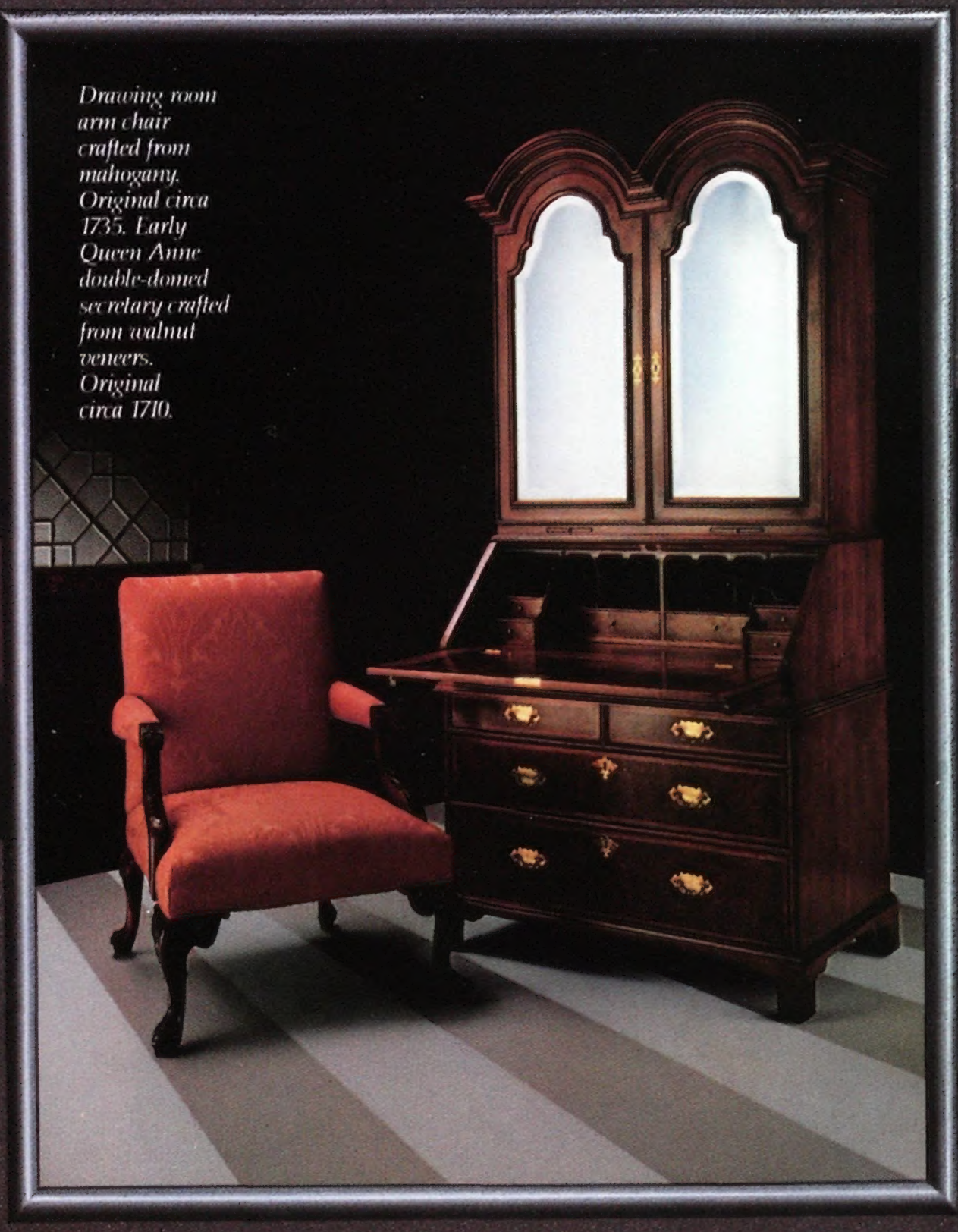

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April 1986

Smithsonian

Volume 17, Number 1

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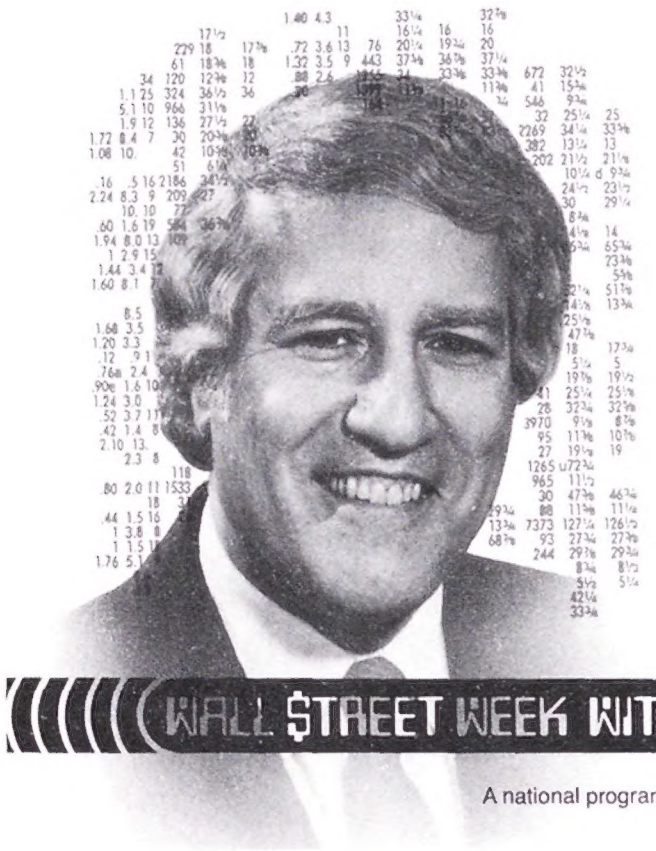

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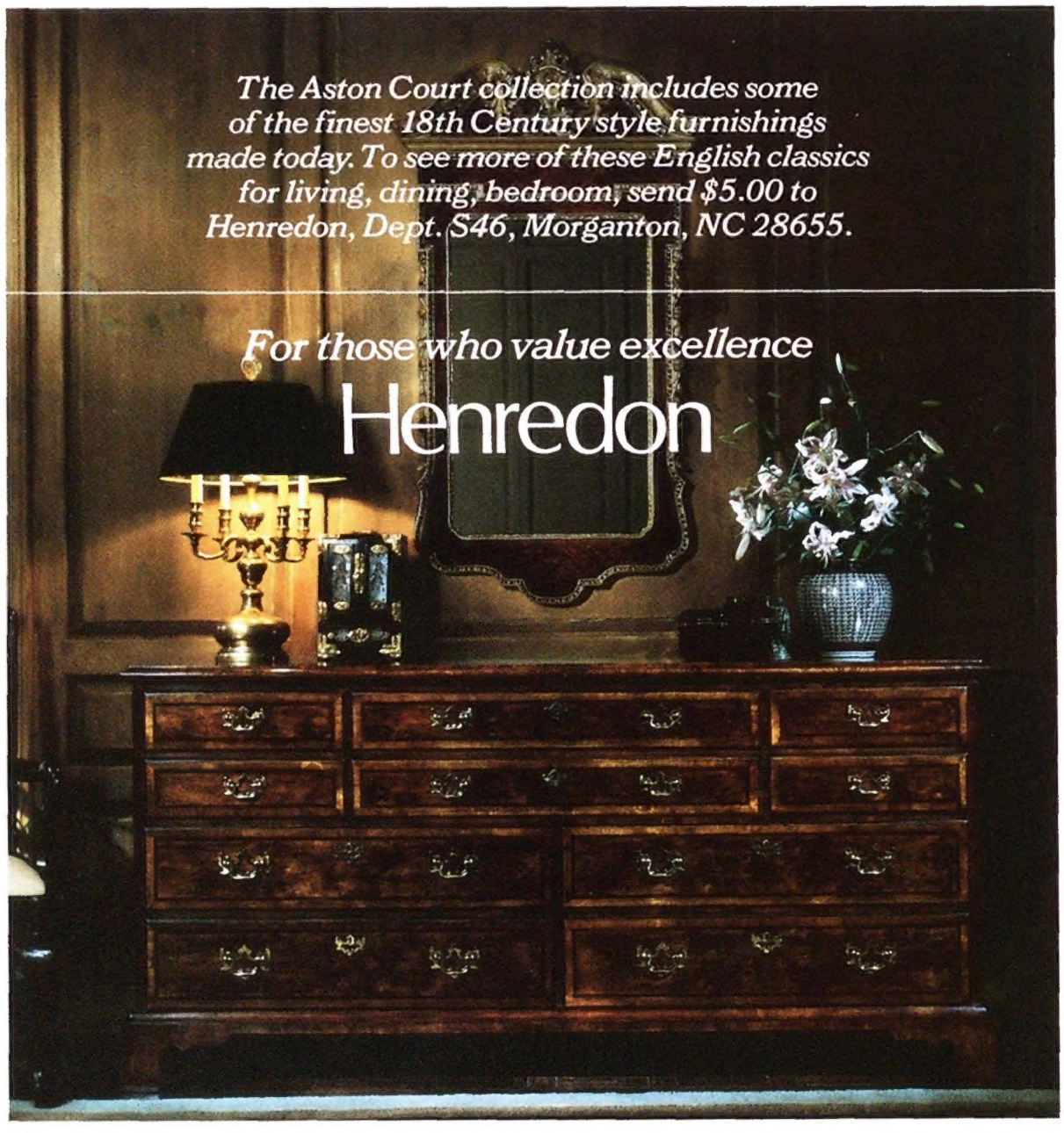
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Secretary Adams' comments

Smithsonian horizons

What will a rise in sea levels, which now seems inevitable, do to our lives —and to our children's lives as well?

There is a solid consensus of scientific judgment that a worldwide climatic warming is well under way. Called the "greenhouse effect," it results primarily from the steady growth in our consumption of fossil fuels and the accompanying increase in atmospheric carbon dioxide. This and other gases produced by human activity do not impede the inward passage of visible light from the sun, but absorb part of the infrared radiation from the Earth that otherwise would pass outward into space. Thus the delicate balance that maintains our climate undergoes a cumulative and increasingly rapid alteration.

It has been estimated from air bubbles trapped in glacier ice that the atmosphere contained about 280 parts per million of carbon dioxide in 1860, while by 1980 this had risen to 339. Several studies make clear that, even with worldwide draconian controls, the level is likely to double by the end of the next century. Average temperature will accordingly rise, although by margins that are hard to predict. A National Academy of Sciences estimate provides only a range: from 2.7 to 8.1 degrees F.

Many complications obscure the outcome of this general change. Increased evaporation and changes in cloud height and cloud cover could intensify the effect, as will ongoing tropical deforestation. Volcanic eruptions act in the reverse direction, although at their historic magnitude and frequency their influence will be relatively slight. Temperatures will rise several times more in polar than in tropical latitudes, and the resultant loss of highly reflective snow cover will add to heat absorption. Oceanic as well as atmospheric circulation patterns will certainly alter.

Very few of us will live to see the full expression of these far-reaching changes. But the effects on the lives of our children, and especially theirs, may be profound. Moreover, the onset of particular features is likely to be not gradual but irregular.

Take the rise in sea level that is already under way at the rate of almost a foot per century. Complicated by uncertainties over the extent of snow and glacial melting, an increase in the above rate to about three feet has been projected for the century to come. Then there are many areas of local geological subsidence to be taken into account. Wetlands in Louisiana, for example, are already converting to open water at a rate of about 40 square miles per year. Much of the East Coast of the United States is also subject to subsidence, so that a net rise there of four feet or more per century will be fairly common.

Many coastal communities will face an agonizing choice as this process continues. Should they try to stay in place rather than retreat landward? Should they go on rebuilding more and more houses after major storms? Should they seek to check beach erosion by constructing sea walls or jetties and groins? These measures are immensely expensive. Will the federal and state governments continue to take a major hand in meeting these expenditures as deficits and risks mount uncontrollably?

The incidence and magnitude of specific destructive storms are unpredictable. How then do we fashion policies that deal with a general problem of this kind, rather than merely responding to increasingly severe and frequent disasters as they occur? As suggested in a recent and comprehensive study of this problem (*Greenhouse Effect and Sea Level Rise*, Michael C. Barth and James G. Titus, editors, Van Nostrand Reinhold, 1984), zoning changes could be encouraged that required particular properties to be abandoned in the event that the sea level rose a certain number of feet in the next century.

But what inducement is there to lawmakers to devote attention—still less, to risk alienating parts of their constituencies in so doing—to problems whose impact will be felt long after their terms of office? There are limitations to what a democracy can accomplish, and this is one of them.

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Letters to the Editor

Muskoxen

Dear Sir: The future for those remnants of the Ice Age might not be as rosy as indicated in your February article.

In September the U.S. Fish and Wildlife Service will submit a report to Congress regarding the future of the Arctic coastal plain. At that time a major effort will begin to force Congress to crack open this fragile area to oil and gas exploration and development. If this occurs, the muskox will not be the only coastal-plain inhabitant to suffer.

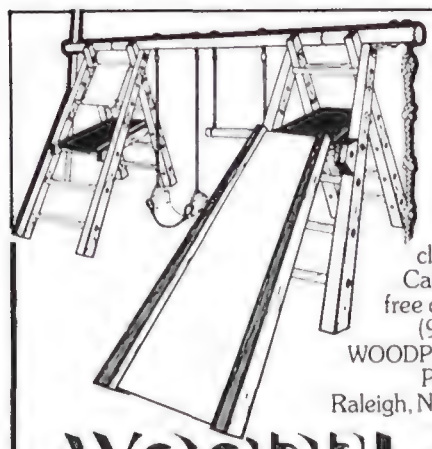
Wolves, caribou, polar and grizzly bears and the endangered Arctic peregrine falcon are among the wide variety of fish and wildlife that would be harmed by industrial activities in this habitat. In addition, the traditional subsistence way of life of the many native Alaskans and Canadians dependent on those species could be threatened.

This situation is just one example of how the constant pressure to develop the nation's last remaining wild lands could make conservation success stories such as this merely ephemeral events.

Susan Alexander
Alaska Regional Director
The Wilderness Society
Anchorage

Dear Sir: Your article brings to mind the agreement, between President Reagan and Chairman Gorbachev at the recent Summit Conference, for mutual cooperation on environmental conservation. It renews efforts begun more than ten years ago, when détente was flourishing.

One of the more exciting projects, in which I participated, was the capture and removal of more than 40 muskoxen from Nunivak Island in Alaska to Siberia, in the spring of 1975. A large Soviet plane came to Bethel, Alaska, a small coastal town on



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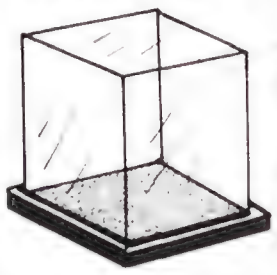

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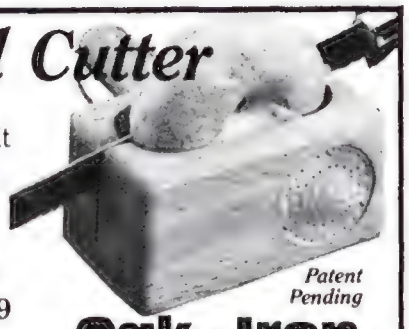

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the Bering Sea, to transport the animals for release on the Taimyr Peninsula and on Wrangel Island in the Soviet Arctic, where it had been determined conditions were right for their survival.

The roundup was similar to those of Wild West days—with snowmobiles instead of horses. Soviet and American wildlife biologists were the "cowboys," herding, tranquilizing, binding and loading the animals onto an aircraft for transfer to Bethel, thence onto the Soviet plane.

Harold T. Jorgenson
Washington, D.C.

Dear Sir: I found no mention of Dr. John Teal, who spent his entire career involved with muskoxen. It was he who brought the animals to Huntington Center, Vermont, in 1954 in a successful attempt to domesticate them.

It was my good fortune to deliver his second child, whom he named "Ptarmigan." He sent me a picture of the baby lying in the grass in the corral with the muskoxen. I scolded him for being unwary of the child's welfare, but he proved to me that these huge animals were gentle, kind and could be trusted.

J. Brooks Hoffman, M.D.
Greenwich, Connecticut

Dear Sir: As a handspinner, I read your article with interest. Qiviut, a luxury fiber comparable to cashmere, is spun—not woven—into yarn with which Eskimo women knit scarves, stoles, hats and tunics.

Vera C. Tonry
East Moriches, New York

Diego Rivera

Dear Sir: When Rivera was painting the Rockefeller Center mural, he was also doing a small, portable fresco for a Trotskyite group's meeting room on East 16th Street. My studio was one floor above it and I dropped in to watch Rivera work.

Everyone in the meeting hall talked all the time and nobody listened. Concerned that the noise would disturb Rivera, I offered him the use of my studio. He thanked me but said he liked working in such an atmosphere, and asked whether he might come up to see my work.

I was delighted, and he came with Frida. I was doing mostly graphics at the time. He praised each print shown him so extravagantly that I said I would be honored to give them to him. An hour later he and Frida departed with much *"Mi casa es su casa"* and about 15 of my best etchings and

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And now, in tribute to the annual festival which honors this elegant flower, The Hamilton Collection presents "Chrysanthemum" – a first-issue plate which marks an historical premiere for the limited-edition world. For *never before has there been a limited-edition collector plate crafted of true Japanese cloisonne* – a treasured art practiced in Japan for nearly 400 years.

The traditional, step-by-step method of creating Japanese cloisonne begins with the affixing of a background of silver foil and fine sterling silver wires to a metal disk. The wells between the wires are filled by hand with the finest enamels, which upon firing are transformed into the jewel-like translucent cloisonne surface.

Skilled artisans carefully polish and fuse the disk to a fine, porcelain plate body and encircle it with a wide band of 23K gold. A rich blue border further enhances the central image – achieved by firing precious metal oxides to the plate in a technique called luster decoration. An outer band of 23K gold adds a final touch of elegance.

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Thus, you are urged to acquire "Chrysanthemum" promptly – especially since its edition limit is just 10 firing days, due to the extensive handcraftsmanship involved. The plate is numbered on its reverse and accompanied by a same-numbered Certificate of Authenticity.

As an owner of "Chrysanthemum," you will win the right to own all seven subsequent Japanese cloisonne plates in a collection entitled *Flower Festivals of Japan. But you will never be obligated to buy another single plate.* And, by ordering now, you will win the right to own all the issues at the same, guaranteed price of $55.00, and pay only half that amount before delivery – with the remainder due upon receipt.

Furthermore, you will risk nothing by ordering "Chrysanthemum" under the Hamilton Collection *100% Buy-Back Guarantee.* Enjoy the plate for 30 days before deciding whether to keep it. If you should return it during that period, you will receive a prompt refund of everything you have paid.

As an important "first," demand for "Chrysanthemum" is likely to be heavy among plate collectors. And a plate of such jewel-like beauty is sure to inspire competition among Japanese art enthusiasts, as well. *Thus, because of the limit of 10 firing days, orders can be guaranteed only if postmarked by the final date shown on the Reservation Form.* To avoid disappointment, send in your order today to: The Hamilton Collection, 9550 Regency Square Blvd., P.O. Box 44051, Jacksonville, FL 32231.

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April 30, 1986

Please accept my application for "Chrysanthemum," first issue in the *Flower Festivals of Japan* Collection. Hand-numbered with numbered certificate. 6" diameter, $55.00 (plus $1.96 postage and handling) each; payable in two equal installments with the first installment due prior to shipment and an invoice for the second installment accompanying shipment. I am under no obligation to purchase any further plates.

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lithographs. It was a small fee for the privilege of watching a great artist working so beautifully.

At the time, Rockefeller was arranging an exhibition in Radio City of the work of living American artists. An invitational show, it meant considerable prestige to be included. The Rivera mural was destroyed three days before our work was to be delivered, and most of the artists protested by refusing to participate in the show. Many picketed the exhibition gallery.

Harry Sternberg
Escondido, California

Dear Sir: I wish you had included the controversial Rockefeller Center mural. The flap went on for a long, long time, and very publicly.

Marion Holland
Chevy Chase, Maryland

The entire mural, photographed shortly before its destruction, is too large for reproduction in this column, but here is the center of controversy: Vladimir Ilyich Lenin. Ed.

The Peace Corps

Dear Sir: Sometimes the commitment of youth lasts a lifetime. Jan Gallagher was in the first group of Peace Corps volunteers to Ecuador 25 years ago. Now, on her own, she continues to help others. Her projects in Milagro, Ecuador, include a technical high school, a demonstration farm teaching French-intensive biodynamic methods, and health clinics in surrounding communities, all funded through donations from her friends.

Lynne Geries
Oakland, California

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Chocolate

Dear Sir: The statues and other artifacts made of chocolate led my mind back to my early childhood. In 1905 our parents took me and my siblings to Germany, where we were entertained by family friends. The most wonderful gift was a small phonograph with records made of hard chocolate. It actually played music—at least the first two or three times. After that the records were broken and eaten.
George W. Bauernschmidt, Rear Adm. (ret.)
Severna Park, Maryland

Dear Sir: Please thank botanist West for pointing out that sauerkraut has more phenywatchamacallit than chocolate. I am looking forward to saving money, reducing weight, clearing up skin blemishes and preventing scurvy.
Davida Mack
New York City

Dear Sir: I spent considerable time at the Sim Hua Seng plantations in East Malaysia, where cacao is rapidly replacing rubber as a source of income. The cacao trees of Malaysia grow and mature far faster than those in Brazil or elsewhere.

There is, however, a disadvantage. The deadly cobra tends to lounge among fallen leaves beneath the tree. Most plantation owners have a flock of geese that successfully drive snakes away.
Michael J. Scott
Seattle

Demise of the caboose

Dear Sir: My father's promotion, in the first decade of the century, from freight conductor to the elite rank of passenger conductor on the Illinois Central was a great disappointment to me, for he used to take us on trips in his caboose. Mother sat on a cushioned bench, but I would scramble to the heaven of the cupola.

Dad told stories of the perils of running along the roofs of the cars during violent electrical storms, the numbing pain of having a finger crushed in the link-and-pin days and the great satisfaction when the 16-hour law was passed.
Anne McCarthy Noonan
Casper, Wyoming

Dear Sir: In 1972, just out of college, I took a chance on romance and hired on as a brakeman with the Boston and Maine. I worked on the spare board for two years before going back for a Master's, and still

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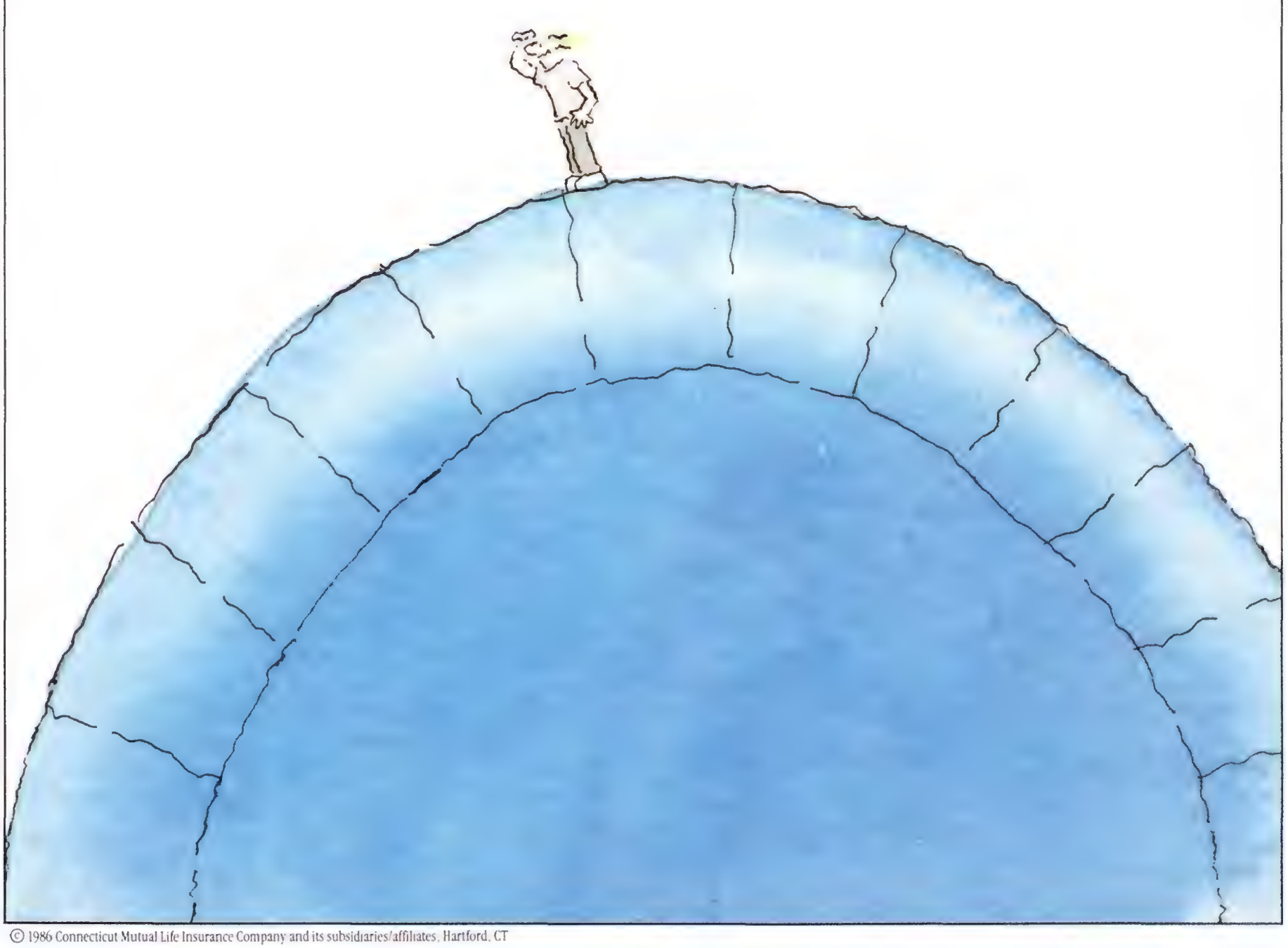

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count that time as the best two years of my life.
John D. Grahame
Northampton, Massachusetts

Whistling

Dear Sir: One sunny day when I was young, strolling down a country road whistling, I came upon an elderly fellow seated on a bank at roadside. He was watching and listening to me. Sheepishly, I greeted him with the couplet often quoted to me by my mother: "A whistling girl and a crowing hen/Will surely come to some bad end." "Not at all," said this kindly and diplomatic old soul. "Whistling girls and milling sheep are the best company a man can keep."
Barbara H. Bell
Watkins Glen, New York

Dear Sir: Cassandra Tate failed to mention the team of Perry Como and Elmo Tanner, who worked with Ted Weems' band back in the 1930s. Elmo was the whistler. Perry got famous.
H. N. Meng
Chevy Chase, Maryland

Dear Sir: My dad had a special family whistle, and we children, when playing outdoors, knew that whistle meant "come home." Mother would play the piano while Dad whistled, and our little dog, at Mother's feet, would howl along—though hardly in tune.
Geraldine H. Gould
Scottsdale, Arizona

Dear Sir: Ninety-three-year-old Lillian Williams deserves more than a mere picture on page 96. She has been a featured participant in the National Whistle-Off for years, has whistled, sung, danced or played ragtime piano for Johnny Carson, Liberace, Mike Douglas, Charles Kuralt, Neil Sedaka, the 700 Club.

She started teaching piano, "400 fingers per week," at age 15, graduated from college in 1912, passed the bar examination with high honors and was probably the first woman to practice law in Arkansas. Finding teaching more profitable than law, she taught for 65 years. At age 88 with failing eyesight, she again hung out her shingle as a practicing attorney, taking only divorce cases. "Those laws haven't changed that much, so I don't have to do a lot of reading."
Lawrence Myers
Clarksville, Arkansas

T formation

Dear Sir: Mr. Furlong owes your readers some explanation of the University of Chicago's disastrous 1939 football season. Chicago was a university with 1,600 undergraduates and more than 6,000 graduate students, competing in athletics with schools where the enrollment was the reverse.

It wasn't easy to convince premed, prelegal and pre-PhD candidates to get out and compete on athletic fields. Then, President Robert M. Hutchins' policy of admitting as undergrads all who had completed tenth grade if they could pass the entrance exams lowered the average age considerably. Try to imagine a teenage bookworm going up against the semipros from other universities and you can see readily how Chicago lost by 60 to 0 in so many games.
Robert I. Spence
Fayetteville, North Carolina

Phenomena

Dear Sir: Having worked as an optical engineer in close association with NASA at the Johnson Space Center during the Apollo program, I found John Wiley's column thought-provoking indeed. I cannot resist a response to Enrico Fermi's "Where are they?" question about extraterrestrials. Since we can deal with time spans in geologic terms, "they" could have been here, but all traces of them erased as the face of Earth changed. The jungle works quickly to erode or hide evidence of some fairly recent societies. Or "they" might have visited in recent times, taken one look at the widespread war and madness and decided to postpone overt contact for another 100,000 years while Man (it is to be hoped) gets his house in order.
L. Richard Lankes
Salinas, California

Mall

Dear Sir: To "make a leg," Mr. Park should simply bow, with the right leg extended well forward, foot turned outward. This will display his no doubt shapely leg, and may be accompanied, as he pleases, by suitable flourishes of the right hand. Silk stockings and a hat suitable for doffing may be worn.
Phyllis J. Cadwalader
Baltimore
Mr. Park gets leg cramps even when he's sound asleep. Heaven knows what would happen if he made a leg while flourishing his hand and doffing his hat. Ed.

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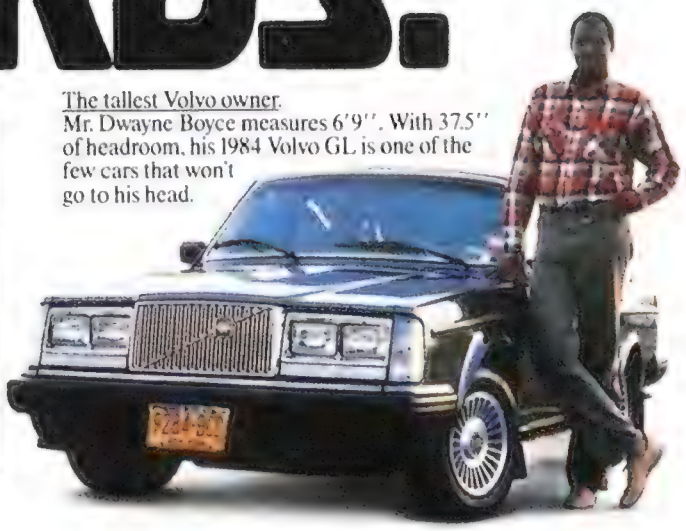

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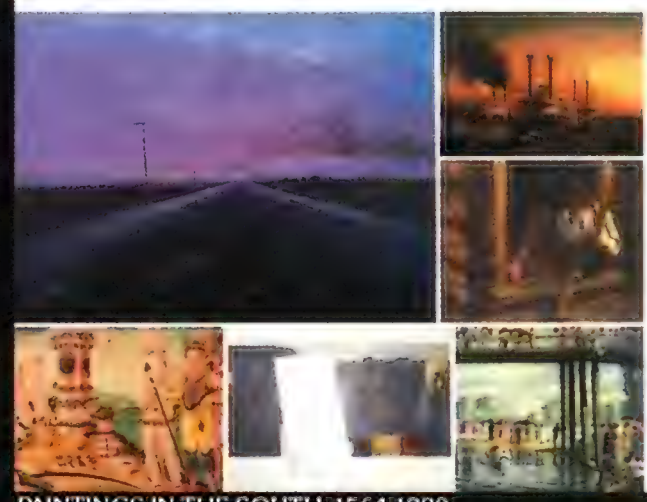

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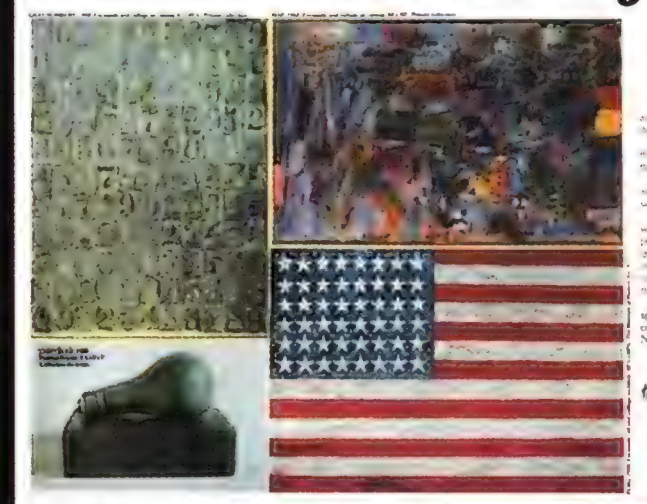

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Do something else to it.
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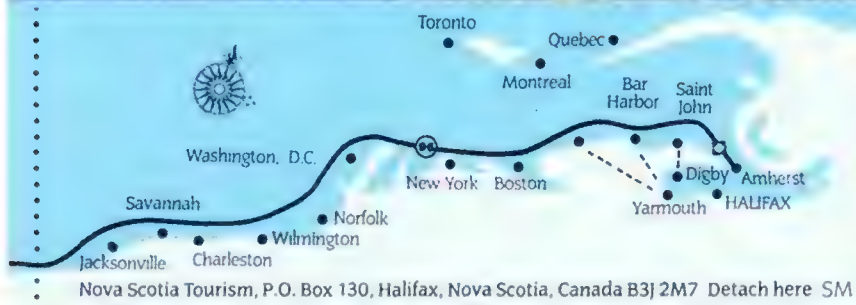

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Around the Mall and beyond

When we look at a new moon in the middle of winter we often see, in the clear, sharp sky, the ghost of the full moon glowing faintly beside the bright crescent. "The new moon is sitting in the old moon's lap," we used to say when we were children. That, incidentally, was back in the days when the air was cleaner and the phenomenon seemed to appear more frequently.

During the enlightened years of our middle age, we finally learned that the ghost moon was caused by what astronomers call "earthshine," the reflection of our own brightly sunlit planet. Now I know something else. If we look at a new moon at the time of the December solstice, when our Southern Hemisphere is tipped toward the sun, that ghost effect will be especially bright. "The dark of the moon shines with the light of Antarctica."

Those are the words of Michael Parfit, whose two-part series on Antarctica appeared in this magazine in October and November 1984. He has since produced a book, *South Light: A Journey to the Last Continent*, which Macmillan published in January. That little note about the solstice effect on the "old moon" comes from Parfit's epilogue. It sums up the visual impact that the Last Continent had on him and will have on you when you read the book—as, indeed, you should. Whiteness, dazzling in the light of the low sun, impenetrable when the snow falls and the wind blows: that's how you picture this mysterious and pristine continent.

It's the impenetrable part that first grabs you as Mike tells of a blind landing in a violently turbulent whiteout at the American base at McMurdo. It was a big plane, an LC-130, equipped with skis, loaded with cargo and passengers for Antarctica. Three times it settled down to 100 feet or

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so and then, without aids to bring it in, without any view except of whiteness, it went around. "The plane and the surface," writes Parfit, "were like blind lovers inches from a kiss."

It did finally land more or less safely with a bunch of very airsick scientists and servicemen. And just after reading that bit, I heard a radio news report of a plane that crashed doing the same thing.

Writers can be pretty dull sticks. They work hard, and their minds get a little befogged, and often they don't have very exciting lives. Mike Parfit is not dull. He's a sensitive guy with a freewheeling mind and a knack for adventure—not exactly a love affair with it, but a familiar acceptance of it. These, combined with a splendid talent, make him a special person.

He's one of very few writers to spend a full season—almost five months—in Antarctica. He seems to have visited everything, from an icebreaker off the coast where 10,171-foot Mt. Siple soars into the clouds, to the South Pole itself, 9,300 feet above the sea, almost all of it solid ice, all of it moving 30 feet a year. Moving northward, that is. Where else?

Michael Parfit stands at cross erected in memory of Antarctic explorer R. F. Scott.

It was at the Pole that he ventured into a bit of Antarctic archaeology. In 1957, the expedition of scientist Paul Siple built a 50-foot-deep living and working complex. It's now called Old Pole and generally it's off-limits because it's as dangerous as a condemned mine. The whole thing is being crushed, smothered, swallowed by the inexorable snow. "At another base that was dying under the snow," writes Mike, "people had reported rivets popping out of bent steel like bullets, firing down the frosty halls. Shot by the wall, crushed by the ice: somebody could be killed."

Yet he wangled permission to visit the buried ghost town, and with three companions, in mind-snapping cold—60 degrees below—found the relics of an earlier Antarctic generation: pinups, a frozen bowl of cereal and a rack of Ellery Queen whodunits.

While down in the frightening, crushing depths of Old Pole, Mike also found frozen T-bone steaks scattered on the floor along with "a fine gravel of frozen broken eggs." Nature's deep freeze. The stuff would be perfectly edible if you cared to try, and, in fact, one of Parfit's companions did take

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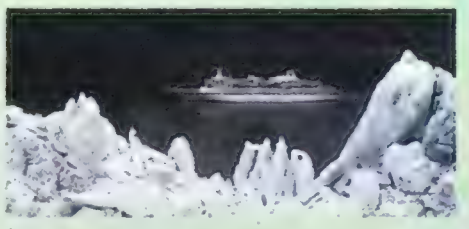

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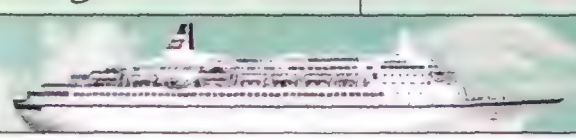

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"Walls of white leaned in upon us. Leaves of frost grew from the walls. We brushed against them and flakes glittered in the lamp, falling in the fog we made with our breath. Wires hung across us, brushed against us like webs, glistening with frost."

Opening a door, Mike found the ceiling broken and the snow taking possession—"a live malevolence, the awful thing hidden behind all these doors decorated with humorous remarks and naked women: the Antarctic nightmare. . . ."

Fully aware of the great white terror, Parfit yet succumbed to the strange, powerful lure of the Last Continent. He was captured by Antarctica a thousand times—even when he joined the Royal Vanda Swim Club, organized at a neighboring New Zealand base, whose members, all obviously insane, were required to swim in an ice pool hacked out of Lake Vanda. "As the water closed over my head I knew that all the mistakes I had made in my life led inexorably to this moment, and that at last and forever, whatever other foolishness I should commit in the future would never come close to this."

Flying back to McMurdo, Mike realized that the combination of adventure, friendship and incredible visual beauty made this "a place so searing and true that I could always return." And return he did, becoming the first outside writer, as far as anyone can remember, to go to Antarctica during its winter. He arrived last August on the new research vessel *Polar Duke* and left in September, on the very first day of spring.

"We were afraid ice would block us south of the Antarctic Circle," he told me. "But we got 200 miles south of Palmer Station, on the western side of the Antarctic Peninsula." His adventures on that trip will, needless to say, soon appear in this magazine.

Michael Parfit is married and lives in Santa Barbara. He is a nut on flying, having bought a home-built plane called a Sidewinder. He also has an old Cessna Cardinal which he turned into a "live-aboard." He tore out the back seats and made a bunk so that he could fly off to an assignment and sleep in the plane. "I also have room for my ten-speed bike," he adds. "That way I can pedal into town for a shower."

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Phenomena, comment and notes

An engineer moves from Apollo rockets to archery and finds that an old weapon can be improved

Bow and arrow. The phrase may conjure up visions of men in green tights running around Sherwood Forest, poaching the king's deer with honest English longbows. Or maybe you think of cowboys and Indians. These were certainly my ideas until I spent some time visiting a modern, state-of-the-art archery manufacturer. I can now confidently report that the bow and arrow, whose lineage can be traced back to the Stone Age, has gone high tech. Robin Hood wouldn't recognize his plaything now.

My introduction to modern archery began, somewhat improbably, at a reunion of my high school class. There I renewed my acquaintance with one of my old pals, Miroslav (Andy) Simo, with whom I had parted ways when he went off to Purdue to study aeronautical engineering. He was the guy in our circle who owned a car, and I have many pleasant memories of cruising around listening to Chuck Berry on the radio of the old 1948 Ford coupe he bought and (barely) maintained.

I would have thought that ownership of such a treasure would have been achievement enough to last a lifetime for any man, but it turned out that my friend's life had taken an unusual turn. He began his career in a conventional way in the aerospace industry, designing plumbing for the Saturn V rocket that carried our astronauts to the moon. In the post-Apollo shakeout of the early 1970s, when many of his colleagues were working in gas stations and driving cabs, Andy decided to combine his engineering career with his archery hobby. The result: New Archery Products, a company that grew from an operation in his

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basement to a million-dollar business centered in a factory near Chicago, where I was introduced to the modern bow and arrow.

From the point of view of a scientist or engineer, the bow and arrow is a simple device. It takes energy generated by human muscles and stores it in the bent and strained material of the bow. When the archer releases the string, the stored energy of the bow is transferred to the arrow, which then travels on its course. But as simple as this system is, it has all sorts of technical problems associated with it.

Take the bow, for example. The energy it can store depends on the material of which it's made. The traditional English longbow was made from the yew tree, and modern engineering studies show that the composition of yew seems to make it the best wood for storing energy. The English longbows struck terror into the hearts of European knights for centuries. Later, with English stocks depleted, yew wood was imported from Southern Europe. To ensure an adequate supply of their most important weapon, the English kings required that anyone who shipped such products as wine from the Continent had to ship a specified number of yew staves as well. The Europeans didn't mind, because it turns out that the wood loses its resiliency at temperatures around 100 degrees F, thereby making yew bows useless during the Mediterranean summer.

But even the best wood can store only a limited amount of energy when it is bent. One way around this limit is just to make the bow bigger—the more wood, the more energy. This is why the longbow was long. Today, however, new space-age materials can be fabricated that far exceed even the best wood in their capacity to store energy. Just as the substitution of fiberglass for bamboo allowed pole vaulters to break through the 16-foot barrier, so too does the use of magnesium alloys and composite materials allow modern bows to go far beyond their predecessors in strength and energy-storage capacity.

But, as so often happens when problems are solved by new technologies, this solution created problems of its own. The stiffer the material in a bow, the harder you have to pull to bend it. This means that your muscles have to be exerting maximum force at the very moment you want to hold everything steady while you take aim. Eventually even the strongest archer finds his hand quivering while he's trying to sight in on a target. Storing more energy may make the arrow go farther, but it

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From left above: Dove (3"H), Dogwood (5"H), Hobby Hawk (28"H), Camellia (4"H), Arabian Stallions (15"H), Texas Bowl (8" Diam.), Blue Heron (9"H), Wren (7"H), Sailfish (8"H), Meadowlark (5"H), Bighorn Sheep (19"H), Snowy Owl (40"H).

makes it harder to make it go where you want it to.

The solution to this problem explains one of the most striking features of the modern bow: the array of cables and pulleys attached to it. The purpose of these devices is to arrange things so that you don't have to exert maximum pull while you are aiming the arrow. Drawing one of these so-called compound bows is a strange experience. At the beginning the situation is familiar—the farther back you pull, the harder it is to hold the string. Then, about halfway through the draw, the eccentric pulleys and cables take over and the tension drops. At full extension, you have to provide only about half the muscle strength that you were exerting halfway through. In effect, the pulleys and cables allow you to store most of the energy in the first half of the pull instead of at the end, as in a conventional bow.

There's nothing mysterious about how this effect is achieved: the principle was known to the ancient Greeks. Archimedes is supposed to have boasted that if he had a long enough lever and a place to stand, he could move the Earth. What Archimedes knew, and what modern bowmakers have rediscovered, is that if you are willing to move something through a greater distance, you can exert a smaller force and achieve the same result as you could by exerting a greater force through a smaller distance. Use a longer lever and you don't have to push so hard. The gears on a multispeed bicycle accomplish the same goal. In low gear, your feet move a greater distance, with less effort, for each turn of the drive wheel than in a higher gear.

This principle comes into play when the bow is bent by cables that pass over pulleys attached to both of its limbs or to both ends of its handle (right). The pulleys are mounted with their axles off-center or are themselves elliptically shaped, so they act like cams. The distance the cable travels around the cam or pulley changes as the bowstring is pulled back and the pulleys rotate. In effect, the length of the bowstring (the lever) changes. At the beginning of the draw, things are arranged so that the cable passes over that part of the pulley closest to its axis, giving the least leverage. As the draw progresses, the pulley rotates around and the distance from cable to axis gets much larger. At this point in the draw, the

Miroslav Simo tests the draw of a new compound bow made by Oneida Labs.

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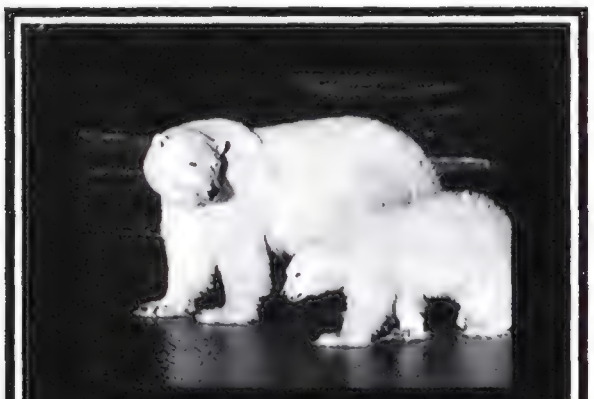
System of pulleys and rotating bow tips provides extra leverage for the archer.

force you need to exert drops off and you can get away with a smaller force while you're aiming.

I was surprised at how many engineering problems there are in the simple act of shooting an arrow. For example, to maximize its range the arrow should be as light as possible. If it's too light, however, when the string is released the arrow shaft will be bent into a S-shaped curve by the shock. This effect occurs because the back end of the arrow wants to start moving, but the inertia of the front end keeps it momentarily stationary. The forces cause the arrow to buckle, an effect you can reproduce by standing a soda straw on its end and then pushing down on it. The theory that describes the deformation of the arrow is the same as that used to describe the buckling of vertical girders in a large building. Obviously, an S-shaped arrow will wobble around as it slides by the bow on its way out, and it will wind up being deflected from the target. The same thing can happen if the fletching (feathers) hits the support as it leaves the bow. Once in flight, the arrowhead can create turbulence as it moves through the air, draining energy to no purpose. All of these problems (and many others) have to be addressed by designers.

Perhaps the most unexpected thing about the bow and arrow is that the problems it presents are so similar to those encountered in much more complex and intricate systems. This point was confirmed by Andy Simo. "Look," he said, sitting at the drawing board in an office overlooking his factory, "I'm an engineer. I know materials and I know design. The basic problems are always the same: you have to find the design and materials that will do the job most efficiently at the lowest cost." To him, at least, there seems to be little fundamental difference between the job of designing a rocket to go to the moon or an arrowhead that will go a little farther and straighter than any other.

This concept, in turn, leads us to a valuable object lesson about the efficient management of research and development in our country. One of the great paradoxes of the history of technology is that the greatest progress often comes in unexpected ways. Earlier in this century, for example, scientists who studied the radiation emitted by atoms discovered many of the laws that govern the atom's behavior.



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One result among many: the digital clock, a device that could never have been developed by a research program designed solely to improve the wristwatch. More recently, scientists trying to build better particle accelerators to study things like quarks have developed powerful, efficient magnets that operate at temperatures near absolute zero (SMITHSONIAN, July 1984). One spinoff from their work: prototype trains that can travel at speeds in excess of 300 miles per hour. Again, we have a result that would never have been achieved by research directed toward improved trains.

Such examples could be multiplied endlessly. They all show a common pattern: first new knowledge and techniques are developed in pursuit of some basic research goal, and then someone (usually, but not always, an engineer) sees how to apply that knowledge in the marketplace. In its own small way, the current high-tech boom in archery illustrates this pattern, with Andy Simo playing the part of an entrepreneur who is able to apply space-age technology to solve problems in unexpected areas. It's unlikely that you would have guessed that educating an aerospace engineer would be the best way to improve the arrowhead, but that's the way things turned out. The message is clear: if you want technological progress, the best thing to do is to train good people and then get out of their way.

James Trefil

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Medical Research—building a healthier future

If you've ever been treated for high blood pressure... heart disease...diabetes...or almost any health problem, medical progress based on research has already touched your life.

Because of medical research, polio no longer strikes in epidemic proportions every summer. Today about three-quarters of patients diagnosed as having Hodgkin's disease will survive five years or longer—as opposed to less than half twenty years ago. Current treatment options for people with heart disease and high blood pressure include medication that helps the body's natural regulators to control blood pressure and volume, enabling the heart to function with less strain.

Scientists are now working on new ways of treating such devastating afflictions as heart disease, cancer and Alzheimer's disease. They are testing new enzyme inhibitors that may control or reverse the late complications of diabetes. Forthcoming breakthroughs in understanding biological processes and treating disease may change the quality and perhaps the length of your life.

Medical research leading to such results takes years of patient, often frustrating experimentation by many different teams throughout the public and private sectors of our scientific community. The tasks involved are not simple.

Advances in research stem from a partnership that includes federal agencies such as the National Institutes of Health (NIH), universities and teaching hospitals across America, and private industry laboratories. Each partner often works independently to acquire knowledge and test new concepts. They must build on the knowledge developed in all laboratories, and they often coordinate efforts in their search for answers.

Whether an idea originates in a university laboratory or starts with basic product research carried on in the private sector, important findings percolate through the entire scientific community, where each new finding serves as a building block to establish a deeper understanding of what we are and how we function.

Medical research is an expensive process. It needs steady funding for equipment and personnel—even when progress is slow. Government and industry often work with university-based scientists and the medical profession not only in the acquisition of new knowledge and the development of new treatments, but also in funding these advances.

Now more than ever, we all must do our part to help keep the flow of discoveries active and ongoing. If funding for medical research is reduced, major advances in knowledge about some of the most dreaded diseases facing us today could be delayed for years to come.

What can you do?

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WARNING

By Richard Wolkomir

A high-tech attack on traffic jams helps motorists go with the flow

Officials in Los Angeles and New York are using sensors, computers and robot video cameras to break up rush-hour congestion

It was the best of times, it was the worst of times—it was Manhattan's afternoon rush hour. For most of the 800,000 drivers who were braking and honking toward the bridges and tunnels leading off the island, it was the nadir of their day, the teeth-grinding hour of creep and stop, of bumper banging, of dyspepsia. But for Samuel Schwartz, it was a golden time: it was his chance to confront the enemy, grille to grille.

A tall, red-bearded engineer in his mid-30s, with serious blue eyes, Schwartz is determined to keep his native city rolling. Until his recent promotion to Chief Engineer, serving as the First Deputy Commissioner of the New York City Department of Transportation, he was head of the agency's bureau of Traffic Operations. In that capacity he led an entourage of agents and tow trucks on a weekly foray through Manhattan, scouting the terrain for potential snarls and leaving in his wake a trail of irate offenders glaring at parking tickets or at the vacant spot where their car, truck, taxi or even police cruiser was illegally parked before it was unceremoniously towed to the pound. Schwartz's officers once even ticketed Mayor Koch. "I could look at all the traffic-flow statistics in the world, but it's not enough," he explained during one of his blitzkrieg sweeps. "There's nothing like getting out here and smelling the exhaust fumes."

Schwartz is one of several thousand professional traffic busters who are out smelling the fumes in cities and

In L.A., electronic signal-control box regulates traffic flow at one of world's busiest intersections.

At an intersection in midtown Manhattan, sign warns drivers not to stop in a box painted on the street.

Photographs by Peter C. Poulides and Kim Steele

The latest in 'car wars' technology

Computers help commuters going to Queens (left), but cars entering Manhattan (right) encounter jams.

During tense moment in New York Traffic Bureau's situation room, controllers ponder rush-hour problem.

suburbs all across the country these days. The reason for their concern is perfectly obvious to anyone who drives. Thirty years after the inauguration of the U.S. interstate system, America's highway-building boom is just about over and traffic is getting worse. How much worse depends on where you live and work. The number of vehicle miles being driven on California's highways has increased by nearly 140 percent during the past two decades, but the highways themselves have been expanded by less than a third. On Atlanta's major urban interstates, traffic volume has jumped 6,000 to 10,000 vehicles during each of the past five years. Freeways serving the high-technology corridors of Chicago's suburbs will soon exceed their capacity by more than 100 percent, while downtown the notorious Dan Ryan Expressway features the most heavily traveled stretch in the nation, with an average daily volume of more than a quarter-million cars. According to the Chamber of Commerce in Houston, traffic jams cost the average resident there $800 per year in time, gasoline and insurance. Nationally, the amount of driving on urban interstate systems increased nearly 15 percent between 1981 and 1983, and a recent study shows that

Color-coded map (right) keys conditions in different locations; video screens at back show trouble spots.

about ten percent of all daily urban travel presently occurs under congested conditions.

Samuel Schwartz and his fellow experts are well aware of the problem, but they're caught up in a vicious circle. Expanding the amount of traffic that a street or highway system can absorb will ultimately only encourage more and more cars and trucks to use it. That, of course, forces planners to start all over again. New York City is the quintessential example of this, but many other hard-pressed municipalities are similarly afflicted.

A number of metropolitan areas are attempting to unclog things by prescribing who and what can drive where and when. Separate lanes, sometimes referred to as "diamond lanes," are being set aside for buses during rush hours. Other roadways or freeway lanes are being designated exclusively for use by autos containing three or more passengers. In some areas, diamond lanes and high-occupancy-vehicle (HOV) use are combined; elsewhere, they are designated separately. Such rights-of-way have proved highly successful in Washington, D.C.; San Bernardino, California; and Pittsburgh. Houston's 100 miles of HOV lanes are so popular that the city is planning a 70-mile busway altogether separate from its conventional highways.

A regular contributor, writer Richard Wolkomir resides in Vermont, where the traffic is still tolerable, he reported recently—"but just barely."

New York traffic official Samuel Schwartz supervises removal of vehicle parked illegally on a city street.

In some areas, commutations among suburbs now far outnumber commutations from suburbs to cities, and many corporations are trying to ease the traffic they create. In suburban San Francisco, the Chevron Corporation and Pacific Bell stagger their work shifts. Sunset Development Co., building a huge office park in San Ramon, California, has spent millions on highway improvements and its own bus system to carry commuters to a transit station. Fast-growing Fort Collins, Colorado, no longer rigidly separates residential and industrial zones. Instead, it has developers organize new housing schemes around industrial plants and office complexes, thus minimizing traffic. New York's Westchester County, predicting more than 100,000 new jobs in the next 15 years, plans to encourage industries to settle in older cities such as Yonkers, which already offer public transportation. Other suburbs, like Walnut Creek and Corte Madera, near San Francisco, have opted to ban most new commercial development until traffic problems are solved.

In many places, congestion has become so impacted that drastic measures are required right now. That's why more and more localities are turning traffic control over to computers. The most advanced of these new electronic systems are being installed in New York City and Los Angeles, where engineers are connecting

The latest in 'car wars' technology

Radio-station helicopter pilot sizes up Los Angeles traffic at junction of Santa Monica, Harbor freeways.

computer networks to sensors imbedded in roadways, and setting up emergency teams that speed to jams spotted by computers and robot video cameras.

New York's Traffic Bureau is computerizing because the number of vehicles entering the city goes up every year and experts already have wrung virtually all of the efficiencies they can from traditional traffic-control tricks. Between 1980 and 1985, they managed to increase speeds on Manhattan's avenues by 18 percent, and on the crosstown streets by 28 percent. To show how it was done, Samuel Schwartz recently took a visitor for a ride. He rolled down Second Avenue in a tan Plymouth, driven by traffic officer Alfonso Martin, with officer Dorita Clarke in the backseat, ticket book ready for action. In a car behind were four more ticket writers, followed by six tow trucks.

The Transportation Department's Parking Violations Bureau has been embroiled lately in one of New York's biggest political scandals in years. The Traffic Bureau has steered clear of that mess, and a good thing, too: it has enough problems already. Many of the city's streets, bridges and tunnels are 30 to 50 years old; the Brooklyn Bridge recently turned 100 (SMITHSONIAN, April 1983). Such an aging structure means constant, traffic-slowing repairs. The problem is common to many older cities. "That's why I hunt for ideas in Europe before Chicago, and in Chicago before Los Angeles," Schwartz said as his caravan cruised along.

It was from London that New York borrowed its "Don't Block the Box" idea—painting a box on the pavement at critical intersections, with signs warning drivers not to nose into a box unless they can make it all the way through. A car stuck in the intersection can stall traffic for blocks.

Schwartz is also trying out the "Bordeaux Bottle Theory," which originated in France. It calls for fine-tuning the traffic lights' red-green cycles to hurry vehicles out of intersections that are becoming jammed, while slowing vehicles that are trying to enter.

Artfully worded street signs in Paris inspired Schwartz to redesign New York's signs, eliminating the ifs, ands, buts and other verbal clutter. "We saved 7,659 words in midtown Manhattan alone," he said proudly. Many of the new signs have a distinct New York flavor. Cruising down Second Avenue that afternoon, Schwartz pointed to one reading, "Don't Even THINK of Parking Here!" And another: "No Parking, No Standing, No Stopping, NO KIDDING!"

Illegal parkers who block lanes, creating "vehicular friction," are one of Schwartz's pet peeves. Spotting an out-of-state van brazenly parked directly under a "No Parking" sign that afternoon, he grabbed the microphone of his car's loudspeaker like Wyatt Earp drawing his six-shooter. "Move it out, brown van!" Schwartz's voice blared over the street. The illegal parker looked bewildered. "You, New Jersey, you're in a no-parking zone—the tow truck's right behind you, so move it!" Schwartz commanded. Looking stunned, the offender eased out into the traffic and disappeared in the downtown flow. Since 1980, the city's get-tough tactics have reduced illegal parking in Manhattan by more than 60 percent. "We've even had the military

California's Department of Transportation supervises vehicles using freeways; the city controls local streets.

complain in a letter signed by two generals and an admiral," Schwartz reported with a touch of pride.

If Schwartz is bearish on limousines, he is bullish on buses. On Madison Avenue, he has reserved two of the four lanes during rush hours for 700 buses. "This one avenue has more buses than the entire transit system of a medium-size city," he said. With trip times pared as much as 20 minutes under the new system, bus ridership on the avenue has increased seven percent.

Although the densely developed city has little room left for adding new lanes, engineers have made use of virtually every other standard traffic-control tool. They can, for instance, make streets one-way and then synchronize the lights so that vehicles traveling at the right speed never hit a red. They can fine-tune the lights to match the traffic volume. They can prohibit traffic-blocking left turns at intersections. They can tinker with regulations.

But the enemy is everywhere. "Holy mackerel—look at this hole in the street!" Schwartz exclaimed at one point, reaching for his radio microphone. "I'm at 22 West 34th Street now and I have a deep utility cut blocking the street," he advised the folks back at traffic headquarters, a grimy municipal edifice at the Queens end of the 59th Street bridge. "Get someone out here!"

Vehicular congestion has riled humans ever since they began congregating in cities. Traffic control dates back to at least the first century B.C., when Julius Caesar banned daytime wheeled traffic in Rome. Later, the Emperor Hadrian limited the number of carts entering the Imperial City. Around 1500, Leonardo da Vinci designed bilevel streets to separate vehicles from pedestrians. Congestion was so bad in 17th-century Europe that some cities created no-parking zones and one-way streets.

The first official traffic fatality

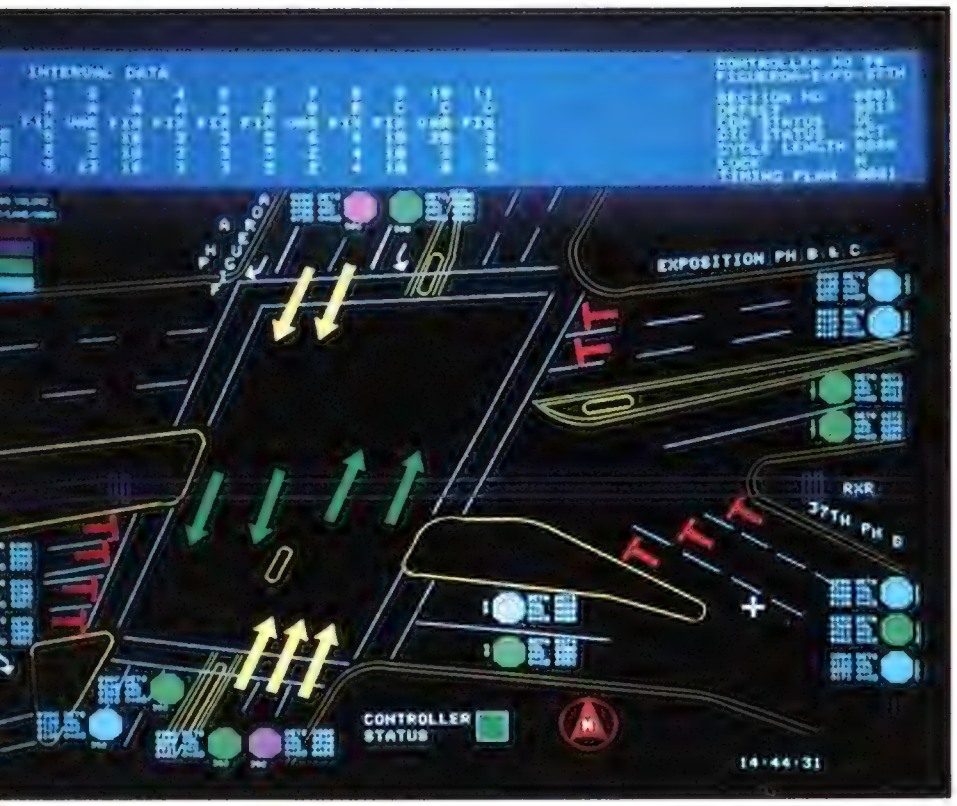
The United States' first recorded auto accident occurred in New York. In 1896, Henry Wells, driving a Duryea electric, struck Evelyn Thomas, a bicyclist. The first official U.S. automotive fatality, also in New York, was recorded in 1899 when Henry Bliss stepped off a trolley into the path of a car driven by Arthur Smith. But traffic on the city's streets must have been dangerous as early as the 1860s, when New York constructed an elevated footbridge over Broadway at Fulton Street.

Traffic signals originated in England in 1868 when London set up manually turned semaphores. In 1908, New York created the Bureau of Street Traffic and set up its own semaphores. The first electric signal lights went up on August 5, 1914, in Cleveland and by 1919 New York City was installing bronze towers to house its electric traffic signals. As late as 1932 one veteran cop, who mistrusted electricity, still rolled out his hand-cranked semaphore every morning at his post on Parkside Avenue in Brooklyn.

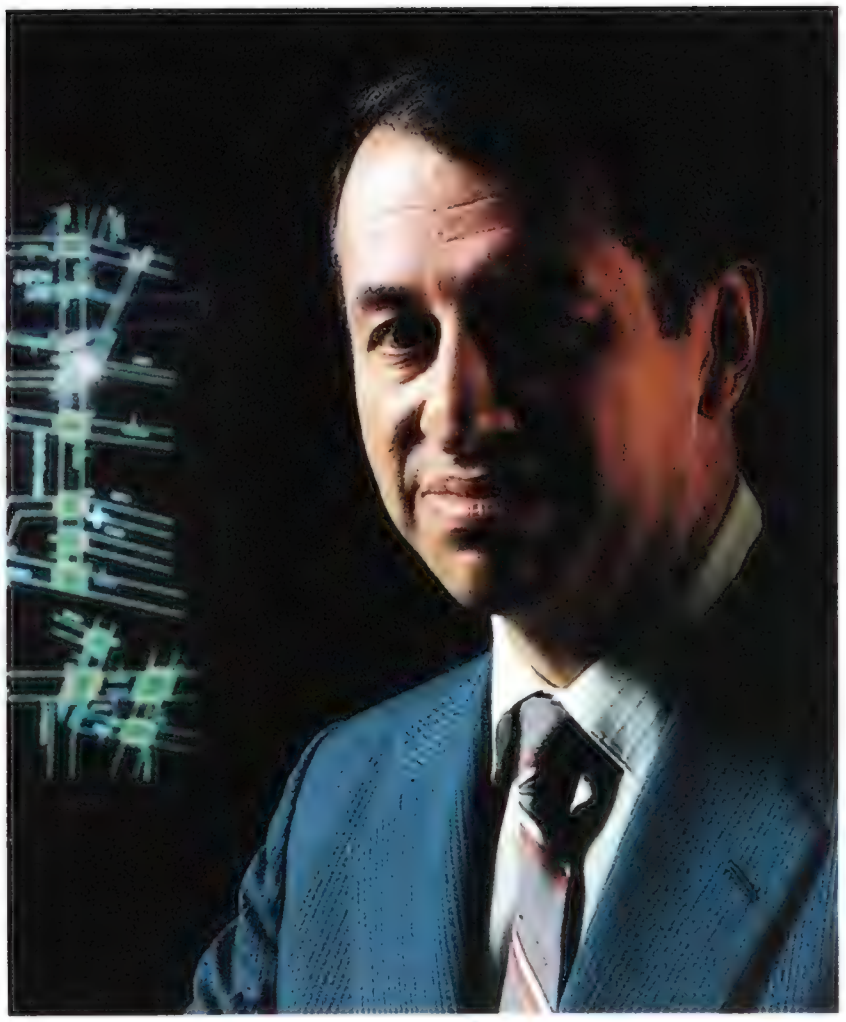
In 1918 the man who introduced electric signals in New York, Deputy Police Commissioner John Harris, proposed a simultaneous solution to two of the city's most troublesome problems: trash and traffic. He suggested dumping all of New York's trash into the East River until it was full, obviating the need for bridges and tunnels from Manhattan to Brooklyn and Queens.

Although the East River remains unobstructed, traffic engineers have managed to funnel ever more vehicles into the Big Apple—from 335,000 a day in 1948 to 860,000 now—and to keep them moving. It is the specter of permanent gridlock that keeps Schwartz moving. Gridlock begins when cars plug up one intersection and spill back to others. Nothing can move for blocks, and traffic agents are helpless. "By about 1991, we'll have traffic volumes *every day* in Manhattan comparable to what came in during the 1980 transit strike, when all public transportation was out," Schwartz says. Ultimately, he believes, only buses and trains can solve the traffic woes of older cities. "Right now, we're just buying time until the transit system improves."

New York's computerized traffic-control system is a



L.A. control-room monitor shows signal indications (arrows), traffic count (octagons) at an intersection.



City traffic official Ed Rowe stands before a screen depicting traffic conditions near Los Angeles Coliseum.

big down payment on that purchase. It relegates standard traffic signals to the status of dinosaurs. "Look at this old light," John Boyajian, an intense, bushy-browed veteran of New York's traffic wars, instructed a recent visitor. He was pointing at a conventional traffic light mounted on the wall like a trophy, only with its innards exposed. "Now we're moving to this," he said, gesturing toward the rows of humming computers and glowing screens on the first floor of the traffic headquarters building. Huge wall maps of the city featured green lights winking on and off in synchronization with the computer-controlled signals out on the streets.

Using data pulsed in from sensors, the computers continually count and time cars traversing an intersection. The sensors are buried in the pavement. Rectangular metal loops as big around as king-size beds, they detect the magnetic mass of vehicles passing overhead. That information is fed into nine large computers, four handling Brooklyn, three for Queens, two for The Bronx. A tenth computer coordinates and collects data from all of the others. As the data on traffic volume and speed come in, the computers mull everything over, then select the most efficient cycles for all of the traffic lights in their sectors.

With the outer boroughs already computerized, the job of computerizing Manhattan is well under way. It is an enormously complex undertaking. "We started by studying traffic flow throughout the island," says Rudy Popolizio, Deputy Chief for Signal Operations at the Traffic Bureau. "Everything from the density and speed of traffic in various directions at different times of the day, to land use along the streets." Traffic behaves differently in different places. In the Garment District (SMITHSONIAN, August 1985), where streets are always clogged with loading and unloading trucks, it moves more slowly and fitfully than it does in apartment neighborhoods. Even a street's shape can affect traffic. Engineers know that if a street narrows or makes a sharp curve, drivers automatically slow down.

After completing their analysis of traffic characteristics in Manhattan, the engineers divided it into five zones, each controlled by one computer. They then divided each zone into subsets; traffic at any intersection directly affects all other intersections within its subset. Subsets affect each other, and zones affect each other too. The programmers take all of these interactions into account, along with the traffic's regular daily cycles such as inbound to Manhattan during the mornings, and outbound toward the bridges and tunnels in the evenings. "We also had to plan for special events like circuses," says Popolizio. "We know what effects these events generate and how they affect important crossing points like the Brooklyn Bridge."

The Traffic Bureau plans to switch Manhattan onto the new computer track gradually, starting sometime in 1988. The bureau has already created a new "intelli-

gence division" that uses robot video cameras to spot mishaps that are causing tie-ups and sends out special emergency teams to clear the blockage.

In operation, New York City's computers run on automatic pilot. Evaluating the data from the sensors, they continually optimize the green-yellow-red light patterns so that the signal lights are continually responding to changes in the flow of traffic. Results? "After the lights are computerized, we find a 70-percent reduction in the number of stops drivers have to make at intersections," says E. Vinson Hoddinott, Director of Technical Services at the Traffic Bureau. "That doesn't necessarily tell you how good the new system is, but it certainly tells you how bad the old one was." When the computers went down recently, the mechanical timers that used to run the system came back on and cars quickly backed up for 25 blocks on Queens Boulevard.

But high tech creates high anxiety. System failures are not rare. On the other hand, the computers instantly warn of any malfunction, pinpointing whether it is in a sensor, or traffic signal, the telephone lines or the computers themselves. That enables technicians to make speedy repairs.

A continent away, Los Angeles—a city whose greatest claim to traffic fame until now has been that its freeways are regularly featured as the butt of Johnny Carson's jokes on TV—is breaking in its own computer system. The differences between New York and Los Angeles are considerable. New York has grown upward; Los Angeles has exploded outward, sprawling close to 4,000 square miles along the Pacific coast. If the elevator made New York possible, the private automobile is the key to Los Angeles. Residents of the often smoggy metropolis drive 5.5 million cars more than 125 million miles per day on more than 722 miles of freeway. The problem is that most of these arteries frequently look like parking lots. Each day Los Angeles drivers suffer through 103,000 hours of delay due to congestion, and an additional 80,000 hours of delay because of construction projects and other blockages. The highest traffic volume recorded at any one point in the world happens to be in East Los Angeles at an interchange of the Santa Ana, Pomona, Golden State and Santa Monica freeways. There, nearly a half-million vehicles—an average in excess of 300 a minute—pass every weekday.

The obvious solution to Los Angeles' traffic problems would be to build another 600 or 700 miles of freeway, but that option has just about been foreclosed because of rising costs and other constraints. Thus Los Angeles, like New York, is in the unenviable position of having to buy time until its mass transit system improves. "Forty percent of the city's peak downtown morning-passenger volume now consists of mass transit and car pools, which we expect will continue," says Allan Hendrix, an official with the California Department of Transportation. Caltrans, as the department is

Lights on map in New York traffic-control room show synchronization of the traffic signals on city streets.

Worker operates pavement-cutting equipment in Queens prior to installation of electronic "loop" sensor.

known, runs the freeways that Angelenos drive, as a newspaper reporter once put it, "like coyotes slipping through the sage." Signal lights now "meter" cars onto the freeways, turning green only when there is room for newcomers. "We used to operate the ramp signals by time clocks, but now we're moving to sensors in the pavement that operate the lights according to the actual traffic flow, minute by minute," says Hendrix. Caltrans has reserved freeway lanes for buses and car pools, and the department helps corporations set up employee ride-sharing programs.

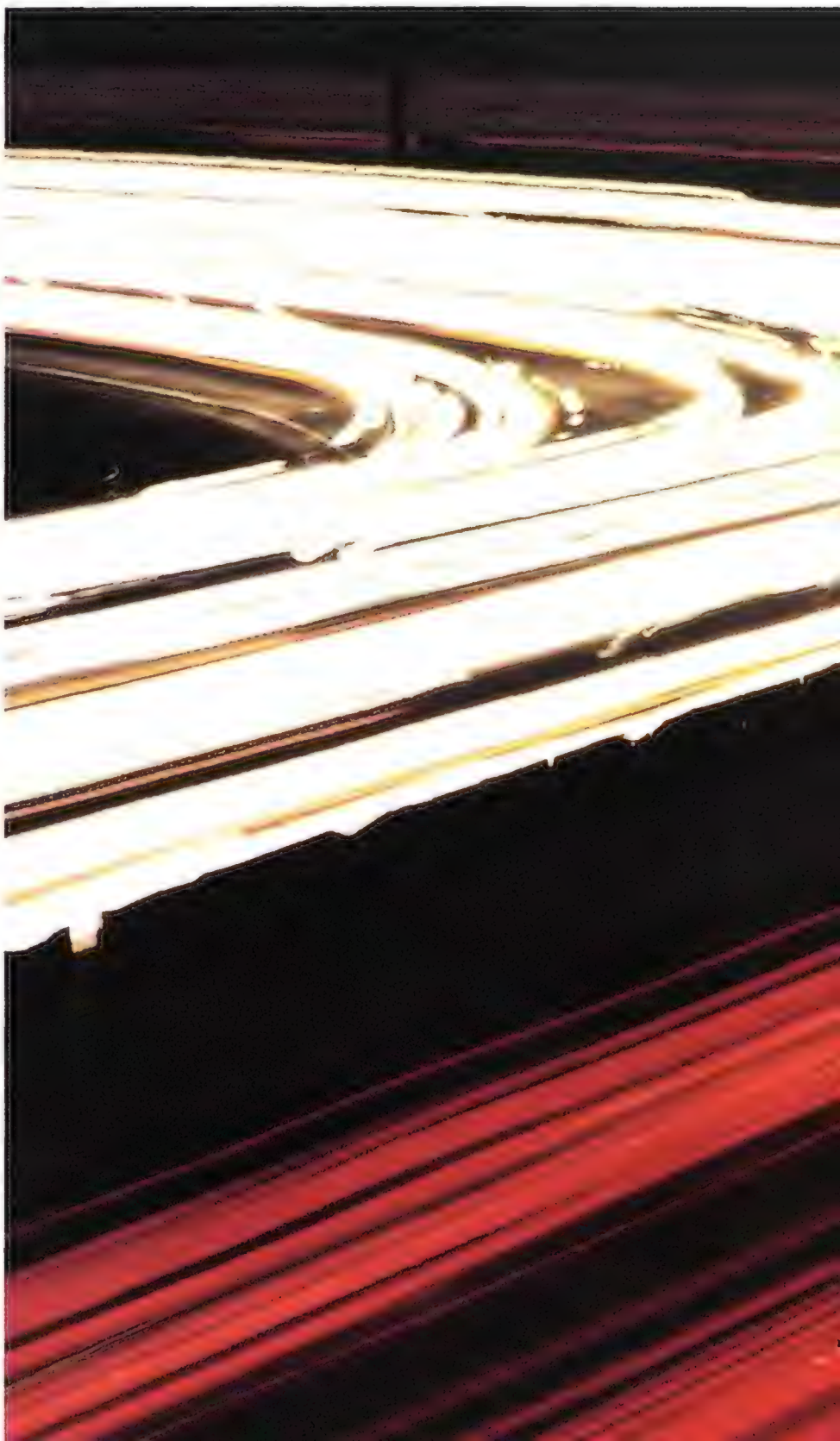
Once vehicles forsake the Caltrans freeways for the streets of Los Angeles proper, they come under the jurisdiction of the city's own traffic-control operation. Los Angeles is sprouting a dense pocket of new skyscrapers downtown, which intensifies the pressure on local arteries. Officials are convinced that computerizing the street-signal system is the way to maximize the amount of traffic that the city can handle.

"Let's look at the intersection of Exposition and Normandie," says Ed Rowe, Assistant General Manager of the Los Angeles Department of Transportation, manipulating a computer's keyboard until a street map comes up on the screen. He has brought a visitor five stories below City Hall, to the control room for the traffic-signal system. The facility combines phalanxes of computers and screens, enormous wall maps of the street system, and control panels studded with switches, dials and pushbuttons. The technology in New York and Los Angeles is virtually the same. Unlike New York's crowded and somewhat cluttered control center, however, this one is shiny, neat and bright.

Rowe presses a button. Up on the screen comes a graphic showing green for Exposition, currently the street with the green light, and red for Normandie. "Good, there's no orange showing, which means the signal isn't malfunctioning," says Rowe, a tall quiet man who is clearly tickled with his equipment. "Watch this." Pushing another button, Rowe makes the map recede to a helicopter-pilot's view. Then he zooms down to study just one side of an intersection. He makes the map blossom into color, each hue indicating traffic volumes at different sites—red for 800-plus vehicles per hour, purple for 500 to 800, green for 200 to 500, blue for under 200. Right now, at 2:30 P.M., most of the map is green, with a few flashing oranges indicating malfunctioning detectors. Rowe zooms in on the intersection of Exposition and Figueroa, where readouts show one lane's traffic volume at 260 vehicles per hour, the adjacent lane at only 240. Such data enables the computer to choose the best light cycles. It also gives engineers centralized control for supervising special events.

After a recent Raiders football game when traffic backed up for a mile on Exposition Boulevard, control-room engineers punched buttons and changed light cycles. "That flushed traffic onto the Harbor Freeway because traffic is like water, always seeking the easiest route to travel," says Rowe. Playing their computer like a piano, the engineers quickly cleared the post-game traffic.

An even more dramatic example occurred on the last day of the 1984 Summer Olympic Games, which Los Angeles hosted. For 16 days, the city had handled the huge influx of visitors without major incident. Then, at 1:30 P.M.—with the final ceremonies due to begin at the Los Angeles Memorial Coliseum at 5



Tremendous volume of traffic keeps moving on Santa Monica Freeway during typical evening rush hour.

—red lights began flashing on the map at the Caltrans control center. Those lights meant that all four southbound lanes of the Harbor Freeway, a major route to the coliseum, were blocked. Traffic officials immediately notified the California State Highway Patrol, who rushed to the scene and reported that a helicopter had crashed into a milk truck, strewing the freeway with fuel and debris. At 2:15, an anxious Governor George Deukmejian telephoned the Caltrans control center, fretting over the closing ceremonies. Officials had long since summoned ambulances, tow trucks and a clean-up crew and had teletyped emergency reports to radio stations. They also put warnings on electronic message signs that dotted other freeways throughout the region. While all that was going on, controllers operating the computers at City Hall had altered the synchronization of street signals in the area to accommodate the redirected traffic from Caltrans' freeways. By 3:45—in plenty of time for the grand finale—the southbound lanes of the Harbor Freeway were back in operation.

Only time will tell whether high technology can help Ed Rowe, Samuel Schwartz and other traffic experts get out of the vicious circle that is keeping their cities and suburbs tied up in knots. Meanwhile, the Austrian town of Grinzing, a suburb of Vienna, has hit upon a decidedly low-tech approach that may merit some serious consideration over here. When fines, radar and signs failed to slow down vehicles on Grinzing's main street, the community bought a gaggle of geese and hired a goosegirl to walk her honking charges back and forth, forcing traffic to reduce speed. Apparently the technique works like a charm. At last report, Grinzing was planning to invest in a few more geese.

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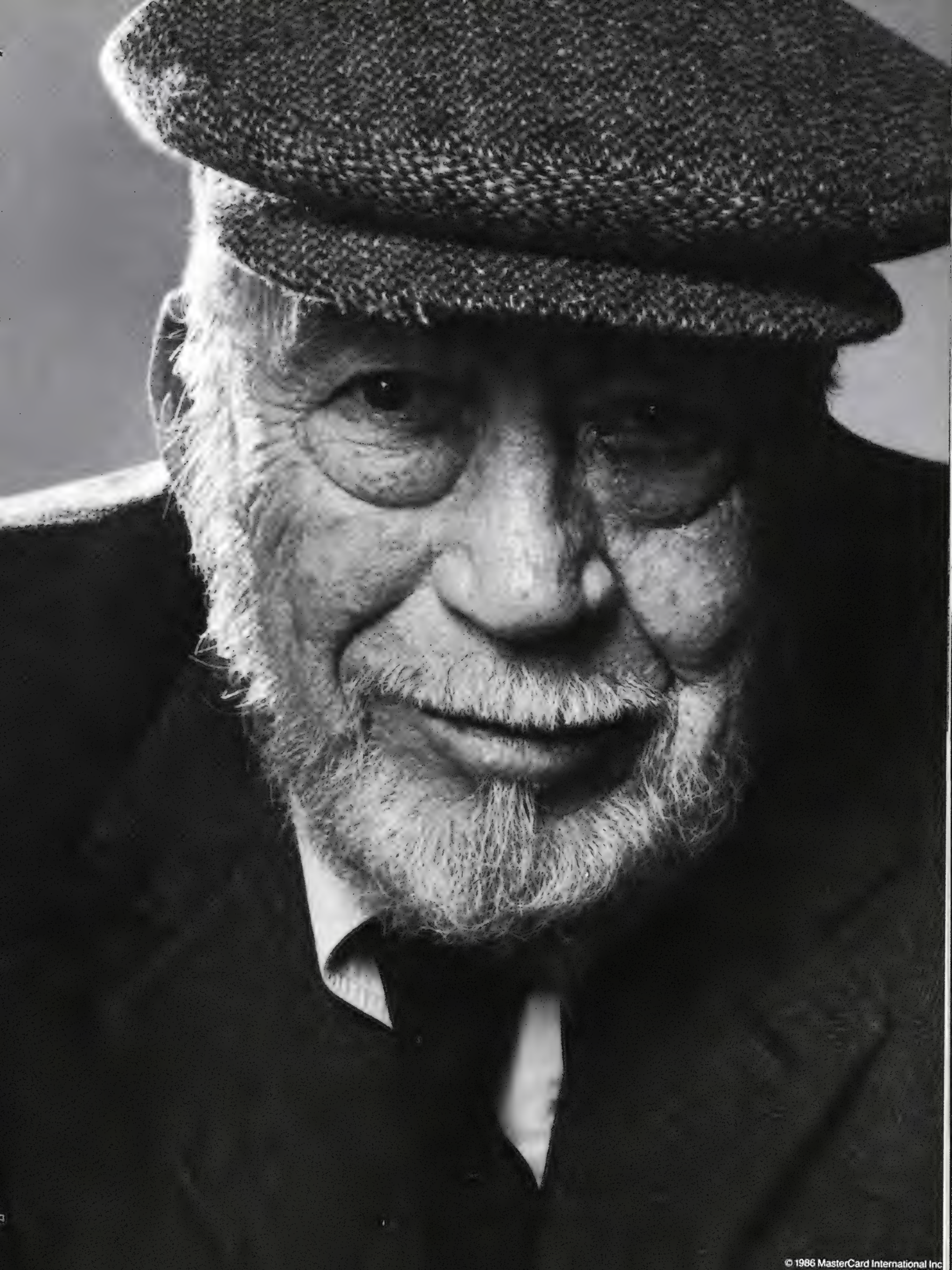

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Article and photographs by David W. Macdonald

A meerkat volunteers for guard duty so its comrades can live in peace

These feisty inhabitants of the Kalahari help each other with everything from raising children to waging war on their neighbors

Author "interviews" a sentry, taping its call for later analysis as part of study on meerkat social behavior.

Imagine a furry brigand about 12 inches tall standing up on its hind legs and leaning heavily on its stiff tail. Its flat triangular head features a sharply tapered snout festooned with whiskers and two impressively pointed canine teeth protruding well below the upper lip. Its beady eyes glitter behind a dark bandit's mask and each of its front paws is equipped with a set of elegantly curved long claws. You may think that you've conjured up the image of a mythical beast, but in fact this creature is real. It's a gray meerkat, distant kin to Rudyard Kipling's Rikki-tikki-tavi, one of the most sociable mammals on Earth—and one of the most pugnacious as well.

Also known as sticktails or, more precisely, suricates, gray meerkats inhabit the vast expanses of wilderness in southern Africa that comprise the Kalahari Desert. The conditions of life in the Kalahari are so unremittingly harsh that these curious little creatures must band together in order to survive. The size of their groups varies from a few individuals up to 30. The degree of cooperation within those societies is so remarkable and the selflessness of the meerkats so conspicuous that their escutcheon, if they had one, would almost certainly be emblazoned with the motto, "All for one and one for all."

Meerkats help each other to do just about everything. They forage and hunt together. They guard each other from predators, baby-sit for each other and pick up the slack when a pregnant female stops working. They help each other raise and protect youngsters, often risking their own lives in the process. They share food with one another. Last but not least, they attack their enemies together, ganging up on any would-be competitors for prey or territory like brawling bands of buccaneers.

Scanning the horizon for danger, lone guard stands watch on a termite mound in the full glare of the sun.

In recent years, field studies of wolves, chimpanzees, gorillas and other social animals have revealed how extraordinarily complex their behavior can be. Until I began following meerkats a few years ago, the details of their lives had never been studied in the wild. My previous research had been on the behavior of other animals, ranging from red foxes in Britain to capybaras in Venezuela. I selected suricates for study because of the tightly knit structure of their groups. I wanted to weigh the various costs and benefits of their sociality and to consider how natural selection might have led to the evolution of their cooperative life-style.

The sands of the Kalahari form an unbroken blanket that underlies the tropical forests of Zaire, runs through Angola and Namibia and surfaces in south-

Female named Interloper looks after another animal's young. While baby-sitter fasts, mother hunts for food.

western Botswana and northern South Africa as the dunes of the Kalahari Desert. There, squinting into a heat haze as temperatures soar to 104 degrees F, it is tempting to dismiss the purist's quibble that an average annual sprinkling of nine inches of rain reduces the Kalahari's official status from a true desert to a mere semiarid zone. The vegetation consists mainly of short grasses and scrub, including fiercely-barbed blackthorns and charred, spiny skeletons of lightning-struck camelthorn acacias. Many of the rivers in the region are ephemeral streams that dry up altogether for much of the year. The Nossob River is more ephemeral than most; water flows between its dusty banks only once every decade or so. Its dry meanders delineate the border between the Gemsbok National Park in Botswana and the Kalahari Gemsbok National Park in South Africa. The two parks, which cover an area of 22,625 square miles, are administered cooperatively by the two countries.

During my study, I stayed with my wife and infant son in a trailer located in the South African park. I found a group of meerkats living nearby, along a parched meander of the Nossob called the Kwang. This was the community in whose company I would spend almost every day for the next six months. I called them the Kwang Raiders because of their unremitting enmity to any and all outsiders, most especially toward their neighbors. Considering their penchant for thuggery, the word "group" is too bland a term for a gathering of meerkats. A gang, a rabble or a mob better captures the tenor of their society.

One day I witnessed a dramatic encounter that told me a great deal about the nature of the beasts I was studying. Hunting for rodents, a silverbacked jackal was trotting down the Nossob when it rounded a brush pile and froze in its tracks. There, 12 members strong, were the Kwang Raiders, mouths agape, backs arched, tails held ramrod stiff. Meerkats are terrified of jackals, but on this occasion the Raiders' nearest bolt-hole lay an unattainable 130 feet off. Consequently, they jostled themselves into a bunch so compact that their fluffed-up bodies seemed to merge, and then they surged toward the startled jackal. At the spearhead was Scar Shoulder, a huge muscular male—if one can use such terms about a creature that would fit snugly into the average pocket. As the Raiders moved they uttered a hissing growl that rose and fell as the mob and the jackal skirted each other.

The jackal twirled around the churning Raiders, trying in vain to break up their formation, but always the hissing mob was at his heels. The jackal was routed

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Three meerkats enjoy a midday break in the shade of a tree while another (standing, in back) keeps an eye out for trouble. The easy intimacy within this group is in sharp contrast to its hostility toward outsiders.

and, as he fled, the meerkats gave chase. Then, as if on command, they turned about and sped to their holes with two big males, Scar Shoulder and Scar Chest, covering the retreat from the rear. (I gave all of the Raiders names based on their scars and other characteristics.) Once safely at the den they fell into an orgy of greeting, sniffing and grooming. Some individuals even clasped each other around their shoulders.

Why do meerkats live in groups? That incident provided at least a partial answer. Strength of numbers can help the diminutive creatures overcome predators that could easily wipe them out one by one.

Meerkats (the name is the general Afrikaans term for mongoose) are not cats at all. They are one of 66 species belonging to the family Viverridae that includes such animals as mongooses, civets, genets and linsangs, all of which fall within the broad taxonomic order of the Carnivora. Viverrids in general are rather like the earliest fossil ancestors of modern carnivores, known as the Miacoidea, and indeed their skeletal morphology and dentition have remained virtually unchanged for 40 to 50 million years. Gray meerkats are sufficiently distinct to be classified in a genus of their own. Their closest relatives are mongooses.

Of the 31 species of mongoose, only six are thought to be highly social. The more solitary species tend to be nocturnal, whereas the social species are diurnal, but the critical difference between them may lie in their feeding behavior. The group-living species are generally more insectivorous and less carnivorous than the solitary hunters. It may be that the abundance and dispersion of the insects that they prey upon enable the social animals to forage together without getting in each other's way.

Every meerkat has two imperatives. On the one hand, it is a rapacious hunter, digging feverishly for grubs and geckos in the red sands of the Kalahari dunes, head wedged deep into tunnels, behind exposed inelegantly (p.60) and unprotected aloft. On the other hand, every meerkat is obsessed with the need to scan the skies for raptorial danger; birds of prey that threaten meerkats include the martial eagle, the tawny eagle and the snake-eating eagle. The dilemma, then, is to be both predator and prey, and the species' remarkable society is the solution. One individual can only trust to luck and waver apprehensively between feeding and vigilance, but for the member of a team there is the chance to take turns and, what is more, to develop specialities and, ultimately, a division of labor.

Meerkats take turns watching for danger in a couple of different ways. First, as the group forages, individuals will pause, stand up and scan the skies for a few seconds. Generally, there is only one animal up on its hind legs at a given instant. To achieve this constancy, each member of a smaller group has to take its turn much more frequently than each member of a larger group. Therefore, the reduction of this disruptive chore would seem to be an advantage accruing to members of larger groups.

The second approach is different, and involves an individual, or rarely two, who takes on the primary responsibility for guarding the group. Such a "profes-

Lined up like prison work crew, Kwang Raiders, as the writer refers to this gang, bask in the morning sun after emerging from their den. Their fluffy fur absorbs rays. Group may spend 20 minutes warming up.

sional" guard will perch in a bush or a tree, sometimes for an hour or more, lambasted by the wind, seared by the sun and exposed to predators for miles around. Meanwhile, comforted by the uneasy peepings which signify that a guard is on duty, the remainder of the group can forage with scarcely a glance skyward. When the incumbent eventually clambers down, hot and hungry, another volunteer relieves him.

Among the Kwang Raiders, everybody except the babies took a turn at guard duty but, intriguingly, each did so to a different extent. Scar Shoulder, the most heavily built male, acted as a guard only rarely and then generally only for periods of duty of ten minutes or less. In marked contrast, the almost equally muscular Scar Chest and the scrawnier Spot Neck volunteered often for stints which lasted for an hour or more.

The devotion to duty shown by those two males was truly remarkable. Although they seemed to be inept climbers, they sought out the highest vantage points. Flinging themselves up into the branches, they frequently slipped and sometimes fell, crashing to the ground with lung-crushing thuds, only to scramble upward again. Of the two, Scar Chest (above) was the more exquisitely daring. Whenever I saw a tiny figure swaying 12 feet above the desert sand atop a wind-buffeted tree, I knew it was he.

The Raiders tried to avoid wildcats, honey badgers and other large predators at all costs, but they went out of their way, interestingly enough, to harass lesser animals (p. 64). Perhaps they simply wanted to banish those enemies from their territory or to discourage them from trying to catch the Raiders off guard when there might be fragile babies in the mob. I saw the Raiders intimidate bat-eared foxes (p. 62) and race along the ground beneath a low-flying goshawk, hurling themselves up into the air and snatching at the

Animals were named for physical characteristics. Third meerkat from left is Scar Chest, the brawniest Raider; to his left is Spot Neck. Scar Shoulder is sixth animal from left. Pregnada is second from right.

hawk's undercarriage. Once, the whole group clustered around a bushy shrub, leaning aggressively into its tangled roots. Suddenly a Cape fox bolted from the sanctuary and the Raiders drove it off.

To make such observations I had to inveigle my way into the lives of Scar Shoulder, Spot Neck, Slim, Lanky, Lefty, Dexter and the others. My first encounters with them were far from intimate. As my jeep trundled across the sand 300 feet or more away, they warily ran for cover. I dogged their trail from dawn to dusk, day after day, until familiarity bred, if not contempt, at least tolerance. The youngsters born to the group during my stay were rarely more than 30 feet from a two-legged shadow and, as a result, they were not averse to a game of rough-and-tumble with a wriggling finger.

The ultimate acceptance came one day when I was crouched down taking a photograph. Spot Neck launched himself at my head, scrambling for a grip in my hair. He finally got a leg up on my spectacles and hopped onto my shoulder to take up his guard duty. At first I was enraptured at this confidence, but the thrill palled when, after ten minutes, my left leg began to get pins and needles; after 25 minutes, it went completely numb. Nonetheless, some perverse code of honor kept me crumpled in a stationary heap until Spot Neck chose to dismount.

Being able to keep such close company allowed me to see every detail of the Raiders' hunting behavior. For meerkats there is no distinction between locomotion and hunting. At every footstep a hole is pawed, a crevice sniffed. A few desultory scratches break the sand's crust, and then a whiff of prey is followed by an explosion of pile-driving vigor as the meerkat digs through its own weight or more of sand in a matter of just a few minutes.

Once I was watching while a female named Slim

Bottom up and tail out, a meerkat hustles for insects. Adult can dig such a hole in about three minutes.

Six of the Raiders scurry across a dusty riverbed while a seventh pauses to glance around for predators.

stretched her long arm as far as it could reach under a log. Suddenly she leaped back, bristling, and then launched a feverish onslaught at the cranny. With a deft flick, she routed a huge red scorpion from its refuge. In a trice the scorpion was up, heavily armored pincers to the fore and slender stinging tail arched up over its body. As Slim swiped at her adversary, the scorpion grasped her long paw between its pincers. Over and over Slim somersaulted, the scorpion's sting flailing at her. Then I saw it strike her forearm, stabbing in a dose of venom. Slim finally managed to throw the scorpion free. Seemingly unaffected by an amount of poison that can incapacitate a man, even kill a child, she whirled around the scorpion, biting it again and again. Finally the prey was pinioned, the battle over and the meal begun. Now, having seen many more such battles, I can only conclude that meerkats are immune to the scorpion's poison.

In the course of foraging, the Kwang Raiders covered an expansive home range embracing a meander of the riverbed of about six square miles. They harvested the prey from that area in a highly methodical manner. Each day they explored one route, thoroughly gleaning every nook and cranny. The next day they followed a different route, and the next day yet another. Often a week or more elapsed between visits to the same spot, and that interval probably allowed the food resources to recover from the previous harvest. Some parts of the home range harbored particular sorts of prey. In the riverbed, the meerkats caught large, furry orange beetles. Grubs of tenebrionid beetles were especially numerous in the red sand dunes, whereas barking geckos and large scarabaeid beetles prevailed in the tangled roots of desert bushes.

On the day that the meerkats won their title of Raiders, they were foraging for beetles in the dry riverbed. I shall never forget what happened next. All of a sudden one meerkat gave a long peep of consternation, and a series of long trills spread from one animal to the next until they were all standing up on their hind legs, peering forward and trilling. At first I could see no cause for their alarm. Then, as they ran to join ranks, I saw another mob of meerkats in the distance, similarly agitated. The Raiders jostled for position, craning their necks and jeering at the neighboring gang.

The next moments were like a dream. The Raiders began to bound, leaping higher and higher into the air, but landing on precisely the same spot each time. The other meerkats, members of the ten-member Nutu Mob, were flinging themselves like synchronized trampolinists in a similar war dance. It seemed that each team was intent upon intimidating the other with a display of their numbers and vigor. Then the Raiders edged forward, bounding as they went. Faster and faster they moved, higher and higher they bounced, with Scar Shoulder and his lieutenants in the lead, until their formation fragmented and they raced toward the Nutu meerkats. Then, as if their morale had snapped, they halted, milling around.

They regrouped on a dusty promontory. Scar Shoulder dropped to all fours and began to dig with powerful rending strokes that lifted clods of silty crust from the riverbed. As the others began to rend the ground, the "smoke signals" rose around them. Perhaps this

The dark tips of the creatures' upright tails may function like flags, helping the group to stay together.

Adult Raider (left) shares a soft part of a relatively harmless scorpion with a youngster about six weeks old.

too was part of a signal to the adversaries of the gang's strength. Again they stood, lurching forward, then scampering back, then forward again as if egging one another on. They groomed one another. They hugged one another. Then they rushed forward and in seconds the Nutu Mob broke ranks and fled. The Raiders pursued them, some overhauling fleeing individuals, and then the contest was over.

Awash with triumph, the victors clustered around the holes where the Nutu animals had been. Scar Shoulder's behavior was extraordinary and suggested that, at least in battle, he was the chieftain of the Raiders. He fell into a frenzy of scent marking, dragging his anal pouch in ungainly sweeps across logs, burrow entrances and other Raiders. He launched quixotic attacks on little shrubs, flinging himself at them and biting and wrestling with their branches. Other Raiders joined in the scent marking and for 15 minutes or more the rapturous self-congratulation continued.

Before calm returned, Scar Chest pursued a private vendetta against a lone straggler from the other group. The two rolled over and over in snarling combat before the vanquished Nutu struggled free and sped, noticeably lamed, for the dunes. Scar Chest suddenly found himself alone more than 600 feet from his group. For half an hour he cast around and when he found the Raiders he seemed oddly cautious. Suddenly they saw him and the reason for his hesitant approach became obvious: once separated from the group, it seemed that he was no longer recognized as one of them. With tails up, the other Raiders rushed at Scar Chest, who cowered to the ground, curling up with his

Scar Chest, who often stands guard for an hour at a time, tumbles forward after losing perch in dead tree.

Raiders combine forces to drive away a bat-eared fox while Pregnada (foreground) serves as a sentinel.

The much larger fox is quite capable of killing a single meerkat, but it is intimidated by a hissing gang.

tail between his legs and rolling onto his back. As they clamored around, they recognized him and the whole group joined in a social hubbub.

The Raiders' unrelenting belligerence as far as outsiders were concerned was surpassed only by their tender tolerance of each other. As the heat of the day peaked, they retreated to the shade and, if their stomachs were full, they began to play. Everybody from the oldest to the youngest joined in a riot of acrobatic sparring. The biggest males would fling themselves on their backs, squirming and wriggling as they sparred and parried with heads thrown back and jaws wide. The scarred matriarch would hop friskily among cavorting youngsters, and meerkats four deep would pile on top of each other in pursuit of an imagined quarry.

To see such unanimous frivolity in so harsh an environment was extraordinary, and all the more so because no bars of hierarchy, age or sex seemed to inhibit the participants. The idea that wolf packs and some other animal societies can readily be described in terms of a linear hierarchy has taken firm hold on the public's imagination. But in the seemingly egalitarian society of the meerkats, the concept of linear dominance appears to be all but irrelevant. The key role of Scar Shoulder in some situations seemed to give him a central place among the Raiders. However, other individuals were responsible for other important tasks—guard duty and baby-sitting, for example—and it is hard to know how to rank them.

The group's cohesion was greatly emphasized when the matriarch of the Raiders had babies. Pregnada, as I named her, was a rather small, almost wizened, animal, but every aspect of her demeanor signified age and authority. Her left foreleg was horribly scarred and stripped of fur and she limped slightly. Her muzzle was pockmarked with pinprick scars, and naked black skin peeped through the fur.

As she became progressively more rotund, two interesting events occurred. First, she ceased to take on guard duty, instead devoting all of her time to foraging. Second, a strange female appeared and began dogging the Raiders' tracks. This interloper spent a great deal of time looking around nervously, having no other meerkats with which to share the burden of vigi-

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lance. As the days passed, she edged closer to the group. She was an adult, more stocky than Pregnada.

One morning Pregnada emerged from the den having clearly given birth. All 12 meerkats set off to forage, seemingly leaving the unborn unattended. Then, to my astonishment, Interloper emerged from the den. She had been left in charge and for three days she attended the babies (p. 56). Whenever she emerged from the den while Pregnada was in sight, the old female drove her back to continue with her duties as a nanny. During those days, Interloper ate little or nothing, her labors seeming to be the price of acceptance, and gradually she did become a member of the group.

It wasn't long before all of the adult Raiders were sharing the drudgery of baby-sitting. That required each of them to fast for entire days—an incredible sacrifice for a small creature accustomed to eating every few minutes. Again, specialists emerged. Spot Neck's devotion to the babies was so great that he seemed to worry about them. Occasionally, when he was several hundred yards from the den, he would detach himself from the group and travel alone—an extraordinary risk—back to the den. There he would briefly cuddle the babies. Sometimes he would even take over from the other baby-sitter, who would then run off to forage with the group.

When the babies left the den for the first time, the adults were clearly apprehensive—and with good reason. Suddenly a Lanner falcon scythed through the air, making straight for a wobbling infant. In an instant the entire group flung itself in a protective blanket over all of the youngsters. From then on, the adults were frenzied in their vigilance. Whenever a youngster lagged behind, an adult carried it back to the nearest hole. As the Raiders foraged, each baby "apprenticed" itself to an adult, and the adults in turn freely donated food to their charges (p. 61).

After each day of frantic activity, the Raiders would return to the den, where they hugged and snuggled together. No single member seemed to dominate any other; each licked and nuzzled its companions. Gradually, sleep-heavy chins settled on shoulders, arms embraced necks, noses probed gently into ears, and a pile of meerkats drifted off to sleep. The unity of the group was complete.

The Kwang Raiders are only one collection of meerkats and my study of them, after 12 months in the field, is still in its infancy. As I continue to record the details of their daily lives and begin to compare them with groups of different compositions and sizes, I will gain a clearer understanding of how and why meerkats live together. It already seems obvious that members of larger groups prosper in terms of vigilance, defense and rivalry with neighbors. They have the advantage of a greater pool of labor for chores ranging from guard duty to baby-sitting. Doubtless there is an upper limit to the group size which is advantageous, and perhaps that is determined by competition for food or mates. The mating of meerkats is one of the mysteries I hope to solve next. It will take years of work to complete this picture. So far, I have seen something new on almost every day that I have worked with these remarkable creatures. I cannot even imagine how many more secrets their astonishing society holds in store.

Scar Shoulder leads attack on yellow cobra, trying to prevent snake from holing up in Raiders' territory.

Alerted by a guard's alarm call, two jittery meerkats scramble to high ground to await further developments.

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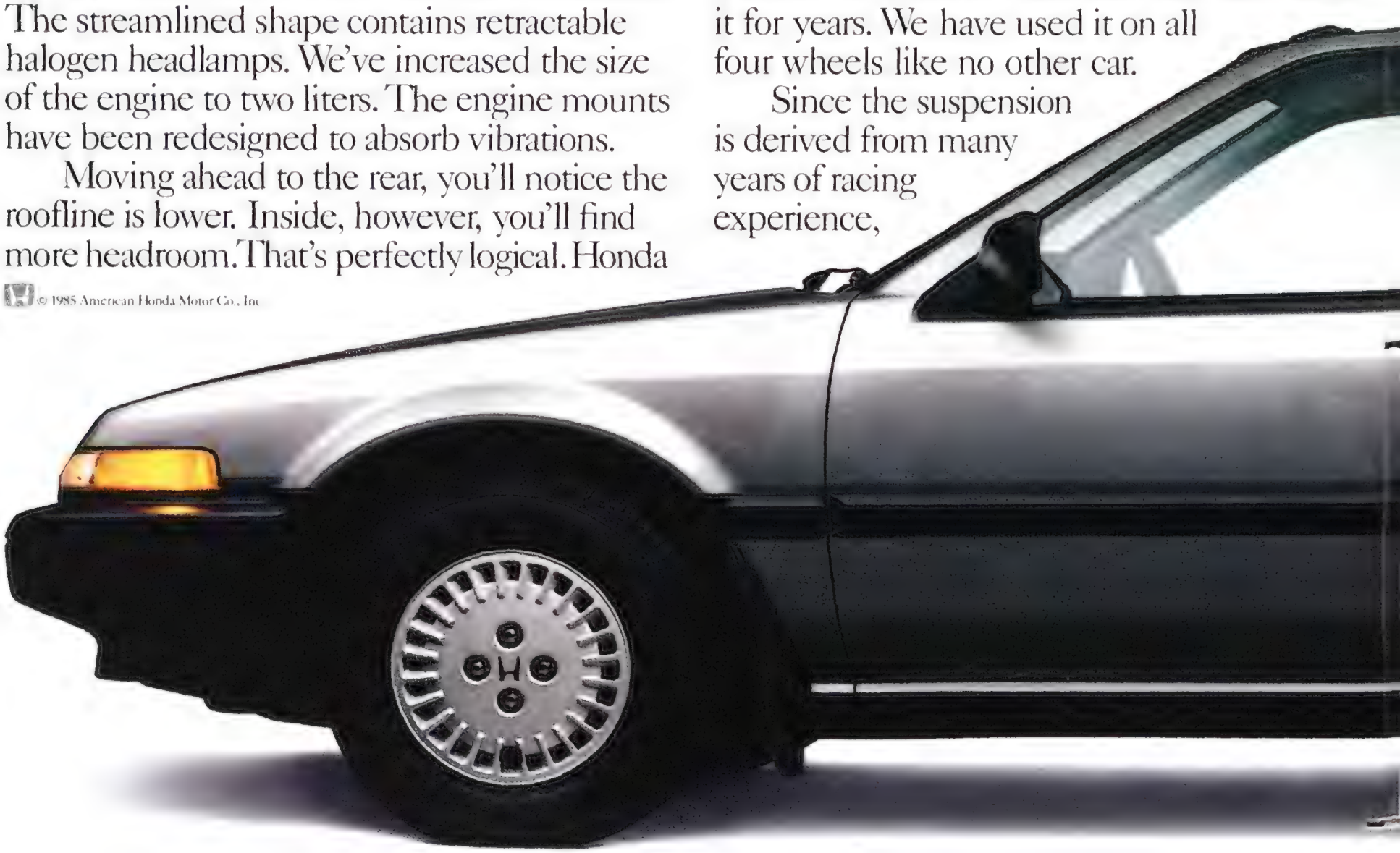

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Water strider, 685 feet long and 80 feet wide, straddles an expanse of land it seems to grow from.

By David Bourdon

Working with earth, Michael Heizer makes art as big as all outdoors

The site is a sandstone bluff 80 miles southwest of Chicago overlooking the Illinois River, at top.

Reclaiming an old strip mine, this artist creates monumental sculptures reminiscent of the work of prehistoric mound builders

Five enormous earth effigies—a snake, turtle, catfish, frog and water strider—arise from the surrounding plain on a 200-acre site that runs along the top of a sandstone bluff overlooking the Illinois River valley about 80 miles southwest of Chicago. The creatures range in height from seven to 18 feet; some extend several hundred feet in length and one more than 2,000. They were designed by Michael Heizer, an artist who helped initiate the earth-art movement in the 1960s.

Photographs by D. Gorton

An artist for whom bigger is better

Rift, a 52-foot-long zigzag cut in the floor of Jean Dry Lake, Nevada, is one of Heizer's "dry bed" works.

He calls his five-part work—one of the most extraordinary earth sculptures ever built—*Effigy Tumuli Sculpture* (a tumulus is an artificial mound, often over a grave)—a deliberate reference to the ancient earthworks that were constructed in the region by prehistoric mound builders.

Heizer's effigies are deployed in a curving line that roughly parallels the edge of the bluff. Two of the animals, the snake and the turtle, appear to descend the bluff and are visible to Illinois River boaters. All of Heizer's creatures are associated with water and are indigenous to the region. The figures cannot be seen all at once except from an aircraft, and part of their appeal is the subtlety with which they blend into the terrain. The effigies are not aggressively monumental, designed to awe or intimidate from a great distance. Instead they seem to hug the ground and, in some cases, are barely visible until the visitor is practically upon them. It takes a while to walk from one figure to the next, to circle and climb them (not always an easy task) and the leisurely progression is a tranquilizing experience, giving one time to contemplate the art, the terrain and humankind's evolving attitude toward the land.

Heizer's *Effigy Tumuli Sculpture* is impressive not just because of its audacious design and sprawling dimensions. What makes it particularly unusual is that it is also a successful effort to restore a former mining site. In the 1930s the property was disfigured by surface mining for coal, becoming an environmental wasteland that had been identified by the state of Illinois as a high-priority area for reclamation. Conveniently located nearby is the 34-acre Buffalo Rock State Park. The barren spoil—the soil and rock overburden that was removed to expose the coal—had been left in ridges up to 20 feet high. The land was so toxic that, even 40 years later, it was virtually incapable of sustaining vegetation. The irregular topography collected rainwater that acidified before flowing into the Illinois River and a nearby lake, polluting both.

Thinking big comes naturally

Heizer himself looks clean-cut and ruggedly handsome in the style of movie cowboys. He has the lean, taut physique that comes from laboring outdoors in a desert climate and he speaks in a low, carefully measured voice that sounds parched. He is alternately self-deprecating and self-aggrandizing. His solemn, resigned and typically staunch attitude seems to indicate that he considers himself beleaguered, perhaps exasperated or merely embittered, as if he is single-handedly creating the only great and serious art of our epoch.

Thinking in millennial terms and epic proportions comes almost naturally to Heizer, who was born in

In 1969 Heizer completed this "earth dye" painting at Coyote Dry Lake in the Mojave Desert, California. His intention was to reintroduce a traditional art medium combined with pretechnological imagery.

Berkeley, California, in 1944. Even as a child, he was acquainted with ancient petroglyphs and megaliths and prehistoric architectural structures in several parts of the world. His father, Robert F. Heizer, was an eminent anthropologist and archaeologist who was a member of the anthropology department of the University of California, Berkeley. Dr. Heizer wrote scores of books and papers on American Indians, and in 1955 worked on the excavations at La Venta, Mexico, including the 100-foot-tall Olmec pyramid, one of the oldest in the New World.

Michael accompanied his father (who died in 1979) on excavations in California and Nevada. Traveling extensively with his parents, Michael visited archaeological sites in Bolivia and Peru and lived for nearly a year in Mexico City. When he was 14 the family spent a year in Paris.

In the early 1960s Heizer studied painting at the San Francisco Art Institute. In 1966 he headed for New York, where he started making geometric abstractions on eccentrically shaped canvases. Eventually, their physicality reached a point where they were evolving into three-dimensional constructions.

With one foot in the doorway of the New York art world, where he was trying to establish his identity, Heizer maintained his strong emotional ties with the Western desertscapes that he had known as a youth. He shuttled frequently from coast to coast. In December 1967 he traveled to the Sierra Nevada in California, where he made a series of "negative sculptures," digging geometric holes and lining them with plywood and sheet metal. In 1968 he made numerous trips to California's Mojave Desert, where he created a group of impermanent sculptures, ground paintings and drawings. He also worked in Nevada, making *Nine Nevada Depressions*. They consisted of shallow linear cuts in several dry lake beds, spaced out along a 520-mile-long route.

Heizer was confident that his "negative sculptures" constituted a radical departure from earlier artworks. "I was determined to be a contributor to the development of American art, not simply to continue European art," he said. "I was intentionally trying to develop an American art and the only sources I felt were allowed were American—South American, Mesoamerican or North American."

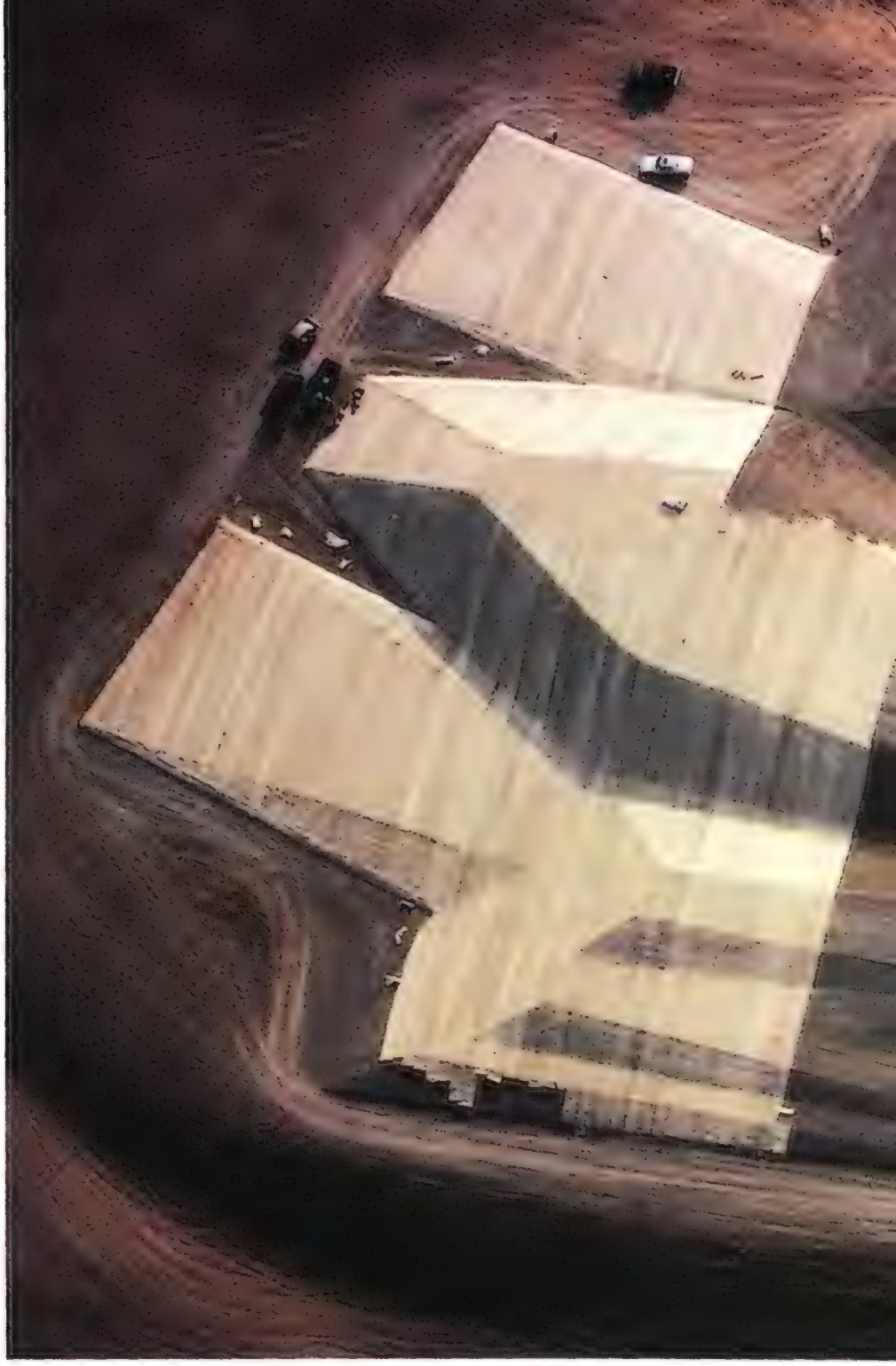
Heizer maintains that he can express whatever he needs to say through the basic materials of the earth—soil and rock. "I found that I could actually have a fairly complete vocabulary that way and that it brought up all kinds of things about the prehistoric or preliterate past, and referred you to a lot of traditions about art that were a lot more interesting than looking at works of art in the Louvre or the Metropolitan Mu-

Formerly an editor for Life *and* SMITHSONIAN, *David Bourdon writes on art for* Vogue. *He is the author of books on Calder and Christo.*

seum." He believes that earth is a "modern" material if rearranged by modern tools. "A pile of dirt 30 feet in diameter could have been accomplished at any time in the past," he said. "A pile of earth 3,000 feet in diameter could only be constructed today with large earth-moving equipment. The material never changed, but the ability to manipulate it gave it a new definition."

Earth art became an official "movement" in October 1968 when New York's Dwan Gallery presented an important group show titled *Earthworks*. Earth art was a seemingly radical movement because it necessarily existed outside the usual gallery/museum context and rejected the traditional concept of sculpture as an autonomous, movable object; instead, it represented a "made-to-order" kind of art that was custom-built for a specific site. At 23, Heizer, who had recently joined the gallery, showed an eight-by-eight-foot illuminated color transparency of one of his *Nine Nevada Depressions*. That same year Walter De Maria staged a provocative solo exhibition in a German art gallery by spreading out a level two-foot layer of wall-to-wall dirt. In 1969, Christo attained international celebrity for his theatrical form of land art when he draped a mile-long section of Australian coastline in tan polypropylene fabric, temporarily—and surrealistically—redefining the topography. In 1970 Robert Smithson created his famous *Spiral Jetty* on the northeastern shore of the Great Salt Lake in Utah; a stone-and-earth causeway, 15 feet wide and 1,500 feet long, it coiled in on itself in the water so that visitors who walked to the "end" of the jetty found themselves in the center of the spiral.

In 1969 Heizer purchased 60 acres on Mormon Mesa near Overton, Nevada, about an hour's drive east



Biodegradable excelsior blanket partially protects the frog, 340 feet wide, 17.5 high, at the Ottawa site.

On Ottawa site, from left: engineer Walter Vegrzyn, Ottawa Silica president Edmund Thornton, Heizer.

of Las Vegas. There he constructed *Double Negative*, until now his most famous earthwork, by blasting and bulldozing 240,000 tons of rock and soil, carving two rectangular cuts, each 50 feet deep by 30 feet wide, on opposite sides of a canyon on the mesa. The cuts are aligned to suggest they are terminal points of a continuous, 1,500-foot-long line. "Obviously the open space between the two cuts is implicated," Heizer said. "This combination creates the double negative. If you can visualize the voids combining, then you understand the work. What's interesting is that the center, almost a third of the sculpture, is an implied volume." (Heizer's former dealer, Virginia Dwan, commissioned the piece for her gallery. Last fall, she donated *Double Negative* to the Museum of Contemporary Art in Los Angeles, which became the first museum to assume proprietary responsibility for a remote piece of land art.)

Since 1972 Heizer has split his time between New

Planted with seed, the excelsior will disappear as young grass takes over early this summer.

Helicopter view of Ottawa project: water strider, center; frog directly above it; catfish in background.

York City and his 1,800-acre ranch in Garden Valley, Nevada, where he lives with his wife, Barbara, about 180 miles north of Las Vegas. During the summers, he and hired helpers usually operate a fleet of earthmoving machinery on his property as they build a "city" of monumental sculptures that may eventually spread over three square miles. The first element, *Complex One/City*, completed in 1974, suggests a mastaba—a huge, horizontal, rectilinear mound of earth with its longer sides sloped at a 45-degree angle—bounded at either end by concrete walls and framed on one side by a discontinuous, partly cantilevered concrete banding. Since 1980 he has been working on *Complex Two*, *Complex Three* and *Complex Four* of the *City*. These uncommissioned works, which he finances himself, are made for his own satisfaction. "I don't contemplate ever finishing," he said of the project. "I'll work on this all my life. I will just go as far as I can."

In 1983 Heizer became a principal in the drama of the Buffalo Rock reclamation project in Ottawa, Illinois. The other leading player was Edmund B. Thornton, chairman of the Ottawa Silica Company (founded by his grandfather in 1900) and president of the nonprofit Ottawa Silica Company Foundation. At one point in its history, Ottawa Silica had bought out a rival firm and thereby acquired the strip-mined acreage at Buffalo Rock. Ottawa Silica had quickly determined that its new property was not feasible as a quarry. "It was too far from our existing plant," Thornton explained; "the railroad had been taken out and there was no way to get the mineral to the plant site. From an economical point of view, the mining and transportation costs would have been extremely expensive."

In 1978, Thornton showed the scarred, desolate site to his good friend Eva J. Pape, a New York art consultant. "It was difficult to envision anything there,"

An artist for whom bigger is better

Thornton recalled, "but Eva had the feeling that perhaps something could be done, using it as a sculptural park." The site had already been designated by the state for reclamation. As a member of the advisory board of the state's Abandoned Mined Lands (AML) Reclamation Council, Thornton suggested to his colleagues on the council that they combine the reclamation with some form of earth sculpture.

Until the 1960s, when all coal-mining operations ceased in Illinois (and many other states), the site could be literally abandoned, leaving behind open shafts and exposed spoils that presented safety and environmental hazards. In 1977, the federal Surface Mining Control and Reclamation Act established standards for abandoned mines. Through federal production fees on active coal operations, a special-purpose fund was set up within the Office of Surface Mining, enabling money to be allocated back to the states for the reclamation of abandoned mines.

Consequently, the Buffalo Rock Reclamation Project was a cooperative venture between the federal and state governments, a private corporation and a nonprofit foundation. The federal Office of Surface Mining provided the reclamation funds—nearly $1 million. The state of Illinois' AML Reclamation Council coordinated the combined effort and oversaw the engineering and construction of the project. The Ottawa Silica Company donated the 200-acre plateau area to the state. And the Ottawa Silica Company Foundation paid the artist's fee (supplemented by a $25,000 grant from the National Endowment for the Arts).

Thornton was initially not familiar with Heizer's work, but was greatly impressed by his background and his family history in mining and archaeology. "Here was somebody," Thornton said, "who was not intimidated by the scale of this site or the enormity of the commitment. He had the capability to look through all the disturbances that were there and to envision something. And he was young and vigorous and had the energy to move forward on the project."

Heizer welcomed the commission but did not want to be perceived as an artist who came in to doctor sick environments. He insists that "reclamation sculpture" holds no interest for him: "I'm not for hire to go patch up mining sites. The strip-mine aspect of it is of no interest to me. I don't support reclamation-art sculpture projects. This is strictly art. I love mining sites. My whole family has been in the mining business—and still is. My maternal grandfather was the chief of California's Division of Mines, and he did the mineral maps for the entire state. My other grandfather was a mining engineer who ran the Nevada-Massachusetts Company's tungsten mine at the turn of the century."

Heizer visited the site, studied aerial photographs of it and soon realized—despite his devotion to totally abstract art—that he wanted to devise large animal forms. He immersed himself in studies of Illinois wildlife, poring through Audubon field guides in quest of appealing insects and spiders. "The way bugs are designed is amazing," he said. "In terms of line, they are all beautiful." He spoke to scientists in university biology departments, and brought back one specimen of clam and various bugs to New York. Continuing his research there, he bought 15 catfish and put them in tanks in his studio. On the Ottawa site, he sought to minimize the need for extensive earthmoving by locating the effigies where dirt was piled up and in one case —the frog—he let the topography suggest the form.

A reference to ancient works

Heizer's Buffalo Rock sculptures clearly refer to the many earthworks constructed in the Eastern and Midwestern portions of the United States by the prehistoric mound builders. The greatest concentration of animal effigy mounds is found in Ohio, Illinois, Wisconsin and Minnesota. Little is known about the mounds, which were constructed between A.D. 500 and A.D. 1200. An ancient, 133-foot-long mound in Wyalusing, Wisconsin, suggests the shape of an elephant lying on its side (though lacking both tusks and tail). Elsewhere in Wisconsin, a pack of six bears seemingly parade across the land. Dozens of tumuli, some representing birds and bears, dating anywhere from 1000 B.C. to A.D. 1000, still exist at Effigy Mounds National Monument near Marquette, Iowa. The most famous of all North American animal effigies is Ohio's Great Serpent Mound. Nearly a quarter of a mile long, the giant snake, whose body averages 20 feet in width, appears to be writhing along the ground in seven great curves, its tail spiraling into a triple coil. Ohio's mound used to be the largest known serpent sculpture in the world,

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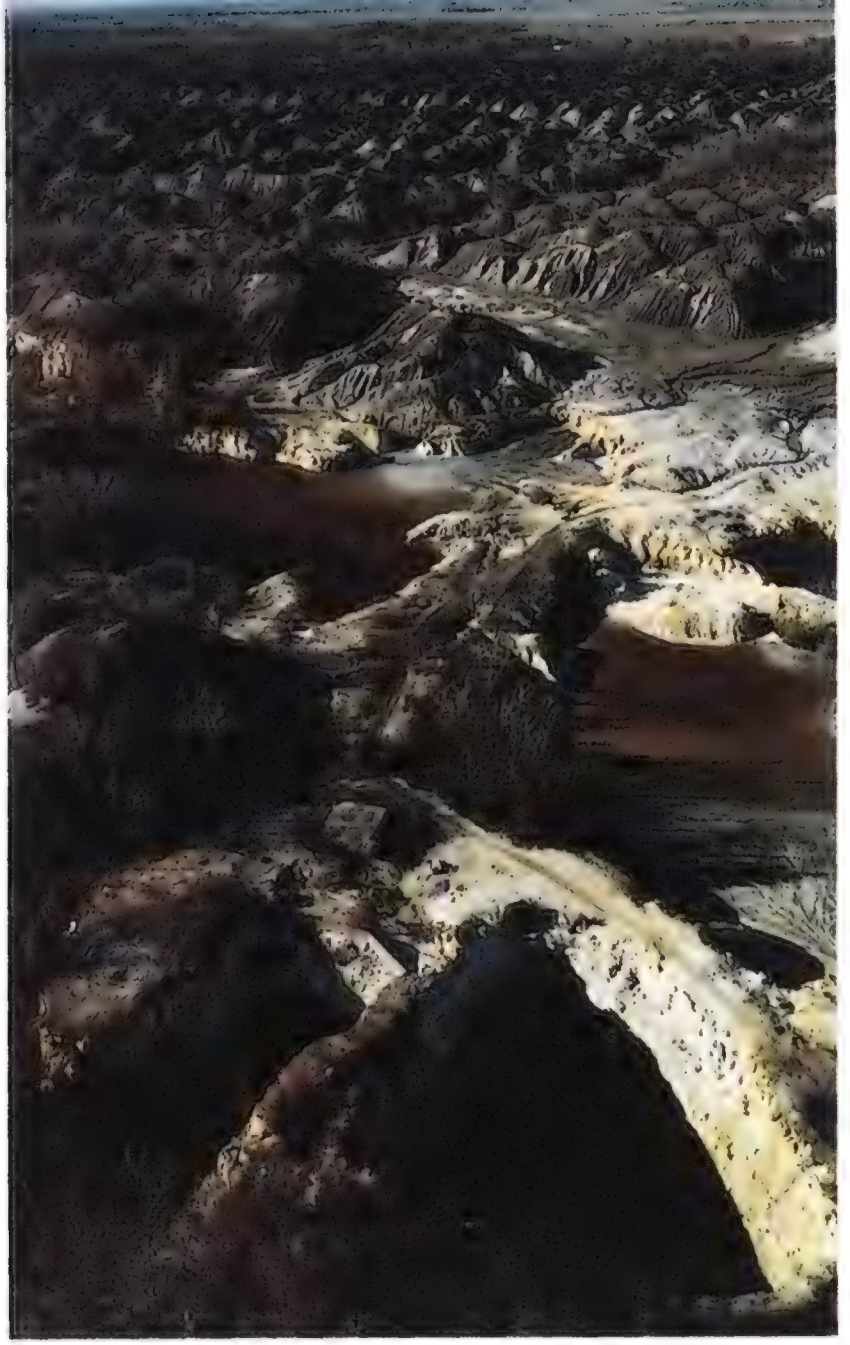


Before Heizer transformed his strip-mined site, it resembled this nearby land, still to be reclaimed.

but Heizer's snake outdistances it by about 80 feet.

The AML Reclamation Council constructed the *Effigy Tumuli Sculpture* in two phases, putting the first portion out to bid in the summer of 1984. "The state badly underestimated the cost of the initial phase," Thornton said, "which was to have built three effigies for $300,000. When the bids came in on the three effigies, they were almost $700,000. As a result, the state said Heizer was going to have to reduce the scale of each figure by 28 percent, and he was going to have to reduce the number of figures from eight to five."

The first phase began in October 1984 with the construction of the water strider and the regrading of 80 acres to provide proper surface drainage. More than six million gallons of acid water were treated and discharged into the river. Then, the acid spoil was neutralized with limestone and seeded with a mix of several types of grass.

Heizer made weekly visits to the site while it was under construction. From start to finish, he found a great deal to be unhappy about: the water strider was inadequately detailed; one side of the catfish was bowed; and, worst of all, the AML plan had included a landform that obstructed sight lines between the frog and the catfish. All of these offenses were eventually corrected. Discouraged by the AML from dealing directly with the contractors or workers, Heizer channeled most of his ongoing field difficulties through Thornton, an able troubleshooter (and ex-Marine). "The AML has been adversarial in some respects," Thornton said. "Michael and I had to fight for every cubic yard [Heizer claims it was every spoonful of dirt], but it has been a very constructive working relationship." All agree the enterprise is a great success.

To the men operating the earthmoving equipment, this was an unprecedented line of work. More experienced at building highways and dams than something as "purposeless" as art, they initially did not appear to take the project too seriously. But once they had been invited to view the incompleted work from a helicopter, their imaginations were ignited. They became converts to the artist's vision. "They are working with delicacies not common to earthmoving," Heizer said.

One of the artist's greatest allies was Donald R. Linton, president of Ottawa's Midwest Landscape Company, whose enthusiasm for the project spurred him to oversee the final definition of the planes, much of it by hand, before liming and seeding the site. "This fine detailing is what ultimately makes the difference between a pile of dirt and a work of art," Heizer said.

Considering the vast scale of the project, the permissible margin of error—two inches—appeared relatively minute, but not to Heizer. "By my standards, a two-inch deviation from the plan is not small," he said; "three-quarters of an inch is an acceptable error in my work in Nevada."

Once the seeded grasses and legumes have fully developed to protect the surface from erosion, the Buffalo Rock site will be turned over to Illinois' Department of Conservation for use as a recreational area; it is expected to open to the public next fall. One of the most heartening aspects of the project is the speediness with which wildlife is returning to the formerly barren land. On the day of the formal dedication of the *Effigy Tumuli Sculptures* last October 29, several visitors sighted deer tracks. Field mice, raccoons and butterflies have been observed and inquisitive hawks are now gliding overhead.

And so a major reclamation, demonstrating a people's resolve to care about their land, has successfully combined with a visionary work of art that may invoke sensations of wonder, mystery and beauty for centuries to come.

An aerial view of the catfish, 770 feet long, 280 feet wide. By last fall, grass was already greening it.

By Dora Jane Hamblin

A unique approach to unraveling the secrets of the Great Pyramids

Mark Lehner's research on the Giza Plateau may answer puzzling questions about its monuments and the ancients who built them

Probably no monuments of lost worlds have been the object of so much awe—and so much pseudoscientific and near-mystical nonsense—as the three pyramids and the Great Sphinx on the Giza Plateau across the Nile from modern Cairo.

In a spurt of energy unmatched before or since, the pharaohs of the Fourth Dynasty managed, from roughly 2700 to 2550 B.C., to quarry and transport 11 million cubic yards of stone and fashion them into pyramids, temples, causeways, without the aid of either beasts of burden or the wheel. And despite a couple of centuries of study, excavation and a flood of scholarly papers, nobody knows exactly how they moved the stone from quarry to pyramid, or what surveying and alignment methods they used to achieve their stunning accuracy.

Now comes the latest and most meticulous effort to find out. It reveals a more elaborate and accurate scheme behind the vast landscaping and architectural project which created the Giza necropolis, inspired by heretofore unrecognized solar alignments between the Sphinx and the pyramids. It is the Giza Plateau Mapping Project, which began in 1984 and will continue for at least two years. Its field director is a young American Egyptologist named Mark Lehner, of the American Research Center in Egypt, working with the blessing of the Egyptian Antiquities Organization. His aim is to produce, with such precise tools as theodolites, electric distance measurers and the technique of photogrammetry, the first complete, highly detailed map of every feature on the plateau, and to extrapolate from it some of the missing pieces of the Giza puzzle (82-84).

"It is archaeologically impossible that the traces of thousands of workmen, of their dwellings and their building ramps, their surveyors' marks, could disappear totally," says Lehner. "The problem has been that archaeology on this site has been on either too massive a scale, with loss of some subtle categories of information, or has been focused too narrowly on individual pyramids, tombs, temples, to grasp an overall picture."

Not that he scorns the early work; he has all but memorized it, and he gratefully lists 101 specific published and unpublished reports from 1757 to 1985 at the end of a brief 50-page preliminary report on the mapping project. Aided by this material and from documentation of visible remains on the plateau, he has already posited a detailed working hypothesis of how it must have looked about 4,600 years ago when the Pharaoh Khufu (called Cheops by the Greeks) began the first structure there, the Great Pyramid. It up-

An enigmatic Sphinx looms above the ruins of its solar temple; in the background is Khafre's pyramid.

While Mark measures huge core stones from Sphinx temple, assistant Abd el-Qadar steadies the datum tape.

Pyramid base was leveled, sides trued using survey line that ran atop stakes mortared into these sockets.

sets many an earlier theory, and Lehner quite equably awaits the inevitable scholarly argument.

The moment he ascended the throne, it was tradition for an Egyptian pharaoh to start building a magnificent pyramid to become his memorial and final resting place. Should he die before the job was well along, his heir was constrained to complete it—an obligation often undertaken helter-skelter, ignoring the niceties of meticulous workmanship.

Such shenanigans had nothing to do with the pyramids of Khufu and his son Khafre (to Greeks, Chephren) on the splendid Giza necropolis. But Menkaure (Mycerinus) of the third and smallest pyramid, unlike his father and grandfather, did not live to finish his tomb complex, which consequently suffered somewhat slapdash treatment by his successor.

In the days of pyramid construction, the vast sandy plateau looked down upon a canal-fed harbor teeming with shallow-bottomed Nile boats. Broad delivery ramps led up from adjacent quarries to the growing pyramid, and 20- to 50-man teams hauled at ropes strung over their shoulders to move 2.5-ton blocks of local limestone slowly upward. The site rang with the sound of copper chisels and stone hammers on limestone, the shouts of foremen, the chants or grunts of the straining laborers. Somewhere, cooking fires burned. There was a bustle of porters delivering food, water carriers slaking human thirst and serving construction needs. There were potters and basketmakers, and the ubiquitous Egyptian record keepers (they were demons for counting and for accounts).

Probably the men worked from dawn to dusk, under

Precise measurements, vital to detailed mapping, are recorded on the map board held by el-Qadar.

watchful eyes of engineers and architects and a cadre of overseers positioned on an outcrop that commanded a view of the harbor, the quarries, the ramps and the workers' quarters. Early conceptions that these men were slaves has been largely rejected by Egyptologists, who now believe they were mostly peasants drafted on a rotating basis for stints of several months each year. They were called up to serve their god-king in a sacred building project, fed, housed and clothed—rudimentarily, one assumes. From quarry marks painted or incised on the enormous blocks with which they grappled, they seem to have found team identities and a pride of accomplishment: one block in the Great Pyramid bore the inscription "The Craftsmen Gang—How powerful is the White Crown of Khnum-Khufu." (Khufu is the short form of the name of the pharaoh for whom they worked; the ram-headed god Khnum was his special protector.) At other sites excavators have found stones marked "The Victorious Gang" or "The Enduring Gang." Some overachievers even marked the laboriously cut blocks "this side up."

Despite their study of all available material, most of what Lehner and his international crew have already deduced comes from analyzing the geological and cultural or man-made traces which still exist on the site.

Logic decrees that there must have been a harbor. Contrary to notions that the building stone came from far away, it is now believed that the great bulk of it was in fact quarried right on the plateau. Lehner has gone a step further: he has identified specific quarries and traced blocks of stone to their original sites. However, some nonlocal material like fine white Tura limestone for casing the pyramids came from across the Nile, and granite for the pharaoh's burial chamber from Aswan, 400 miles upriver. In 1980 Zahi Hawass, then Chief Inspector for Giza Monuments, and the Egyptian Ministry of Irrigation did excavations and core drillings 100 to 160 feet beyond the temples in front of the Sphinx. They indicate a clearly defined drop-off or ledge in the bedrock that is at least 50 feet deep. Now filled with desert sand, it most likely was the rock-cut port of the Fourth Dynasty.

There still exists a series of old drainage channels visible both on contour maps and in turn-of-the-century photographs. Again, logic insists that a series of canals would have connected the harbor with the Nile a few miles away, and would have carried shipborne materials as close to the building sites as possible.

Though still not adequately studied, there exists a massive limestone-block wall south of where the harbor would have been. It is 570 feet long with a ten-foot gateway and it extends almost to the base of the commanding outcrop. Lehner believes it once sealed off the construction and harbor sites from unwanted passers-by and sidewalk superintendents who would have got in the way of the work.

Where would have been the living quarters for those thousands who toiled to build the necropolis? A large sand-filled bowl now lies among the hillocks and outcrops of stone south of the Great Pyramid. An Austrian

Grid would have been used in leveling wide terrace of Khafre pyramid, but the work was never completed.

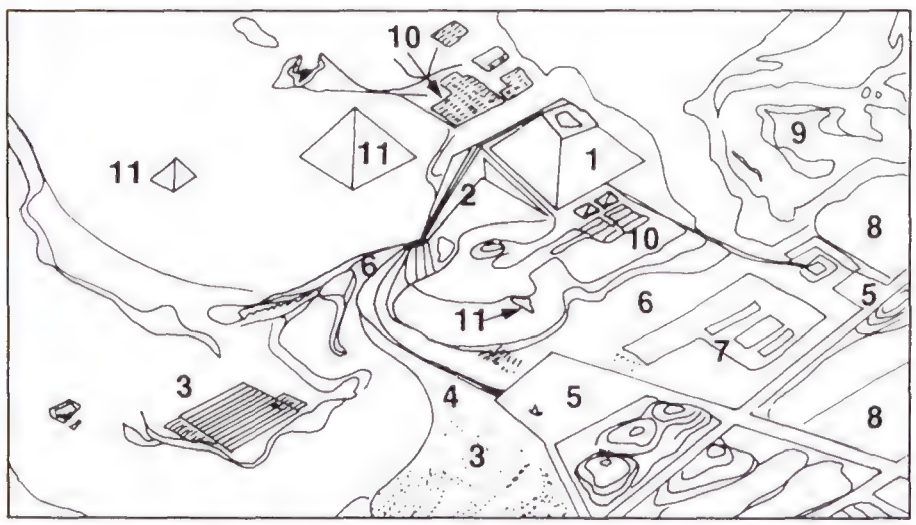
On this, her fifth trip to Giza, the author says she saw and learned more than ever before. Her articles appear frequently in SMITHSONIAN.

Text continues on page 88

The Giza Plateau, 2600 B.C.

Nearing the end of his reign the Pharaoh Khufu had ample reason to be pleased with himself. There on the Giza Plateau, a short distance from his capital city of Memphis, armies of workmen had raised to his order and honor the grandest pyramid in all Egypt, with its fine granite burial chamber. He would not lack companions in eternity: nearby were three queens' pyramids and mastabas for his closest royal relatives. A causeway led down to his valley temple beside a private harbor. From a luxurious palace complex he could admire the architectural splendors wrought in his name. Nor would he be without food—nearby were fields and pastures, and there would be exotic offerings from throughout Egypt. For diversion, there was hunting and fishing in the nearby papyrus swamp.

This drawing shows how pieces of the gigantic puzzle that is the Giza Plateau may have fit together. Mark Lehner has combined known elements based on several centuries of archaeological research with his own findings and theories after two seasons spent mapping the necropolis and five years' study of the Sphinx. Here are the quarries, canals leading from the Nile to a harbor into which came fine casing limestone and granite for the tomb, ramps over which all building material for the pyramid was hauled into place. A workmen's settlement and village for skilled artisans are modeled on those found at other Egyptian sites. For orientation, the later pyramids of Menkaure and Khafre (center) as well as Khafre's Sphinx are represented by the dotted lines.



Key to Giza Plateau drawing:
1) Great Pyramid of Khufu; 2) ramps; 3) villages for workmen and administrators; 4) wall; 5) harbor, canals; 6) quarries; 7) Khufu's palace complex, valley temple; 8) fields, pasture; 9) papyrus swamp; 10) tombs of royal relatives and officials; 11) future sites of Pyramids of Menkaure and Khafre and of the Sphinx.

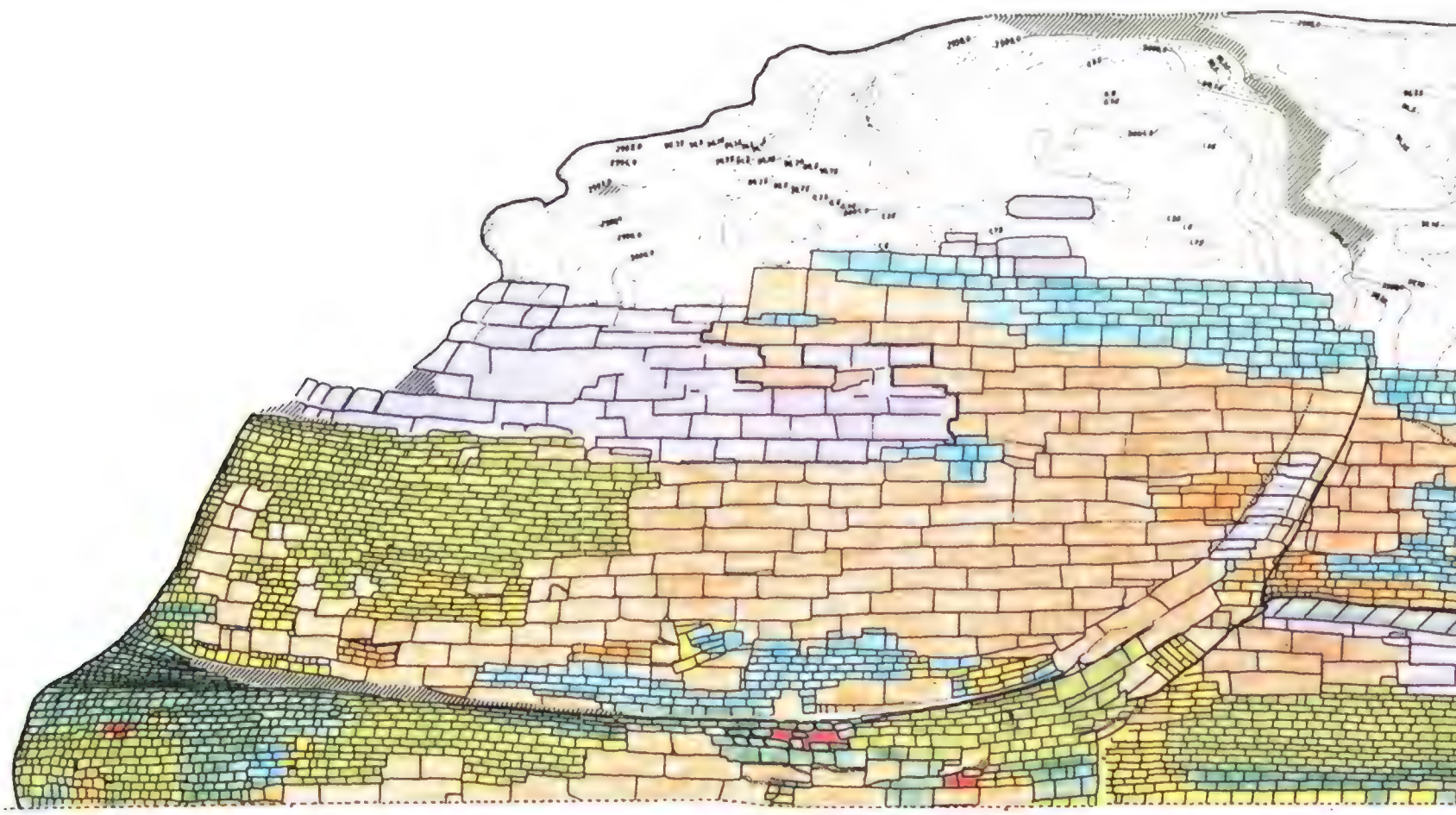
The much-repaired Sphinx

The serenity and mystery of its massive face, the grace and proportion of its leonine form, its sheer size have awed beholders ever since the Sphinx was fashioned 4,500 years ago. Despite depredations of Man and nature—it was used for target practice, credit going variously to the Mameluks and to Napoleon's troops; sandstorms have blasted it, drifting sands engulfed it again and again; salts leaching from its limestone body and the mortar of earlier repairs have eaten away at the ancient stone—there has been, over the millennia, persistent refusal to let it crumble away.

Everybody from a couple of pharaohs in ancient times to Greeks, Romans, Napoleon's expedition and a passel of 19th- and 20th-century Egyptologists, some of whose efforts are shown at right, have excavated, restored and written about the Sphinx. Tuthmosis IV may have been its first restorer, around 1400 B.C. Another ruler had a crack at it 750 years later, and further repairs were made in Graeco-Roman times. The most extensive modern effort until now was undertaken by French engineer Emile Baraize in 1925-26.

The profile produced by Lehner and his colleagues (described on page 91), an example of which is shown below, eloquently summarizes all the admiration and restoration. Armed with his team's collective geological and architectural research, Lehner spent two years crawling over every inch of the recumbent form (840 feet long, about 66 feet high at the head), cleaning, measuring, mapping and color-coding each element to show when and by whom it was placed or replaced. (Dates of early restorations are still uncertain.) The resulting drawings are valuable for art-history analysis and because they freeze the condition of this monument as it was before current restoration.

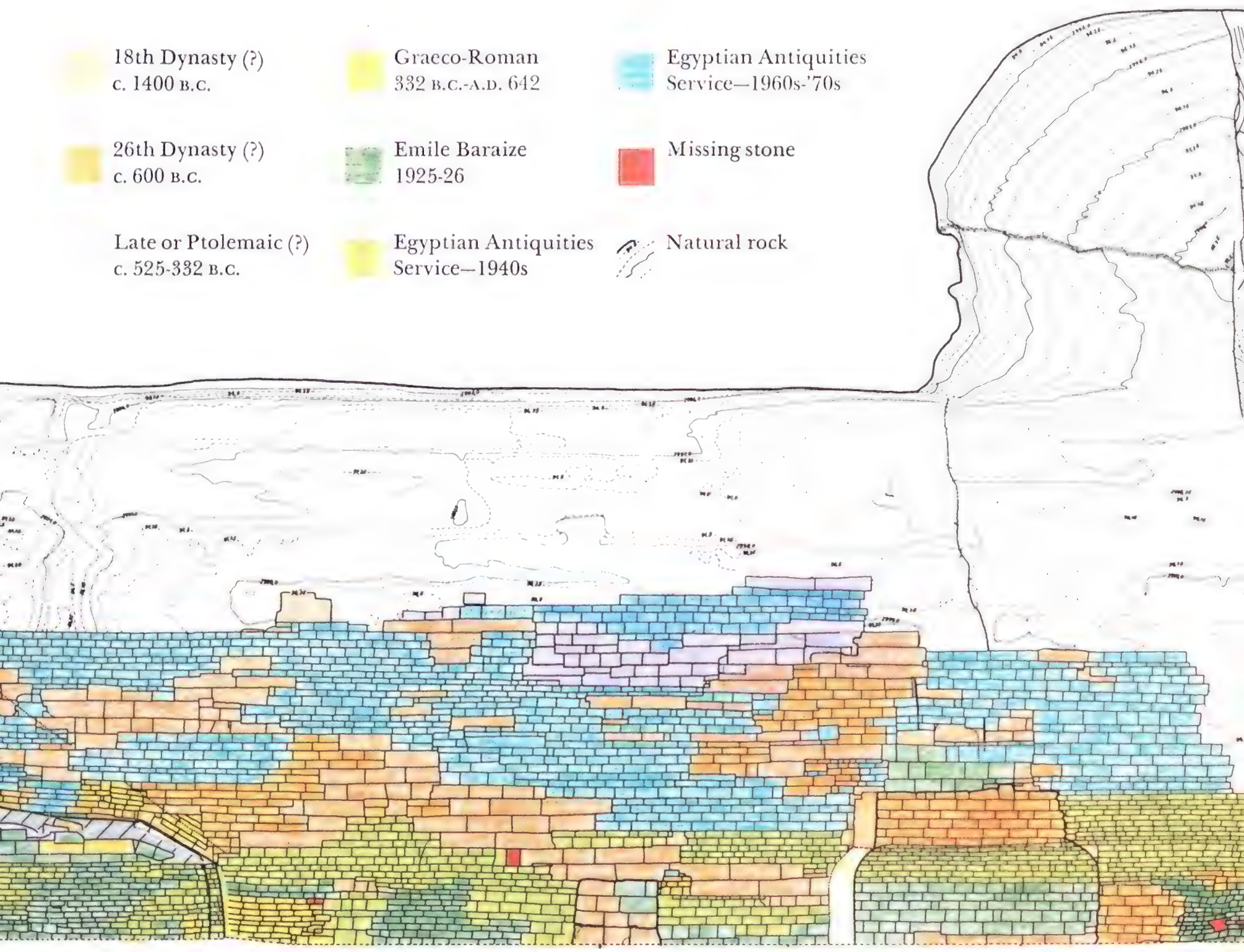
Antlike bevy of workers hustle about the plateau in 18th-century woodcut, under eye of disdainful Sphinx.



Fold out

Artist Vivant Denon accompanied Napoleon's 1798 expedition, made an engraving of measuring process.

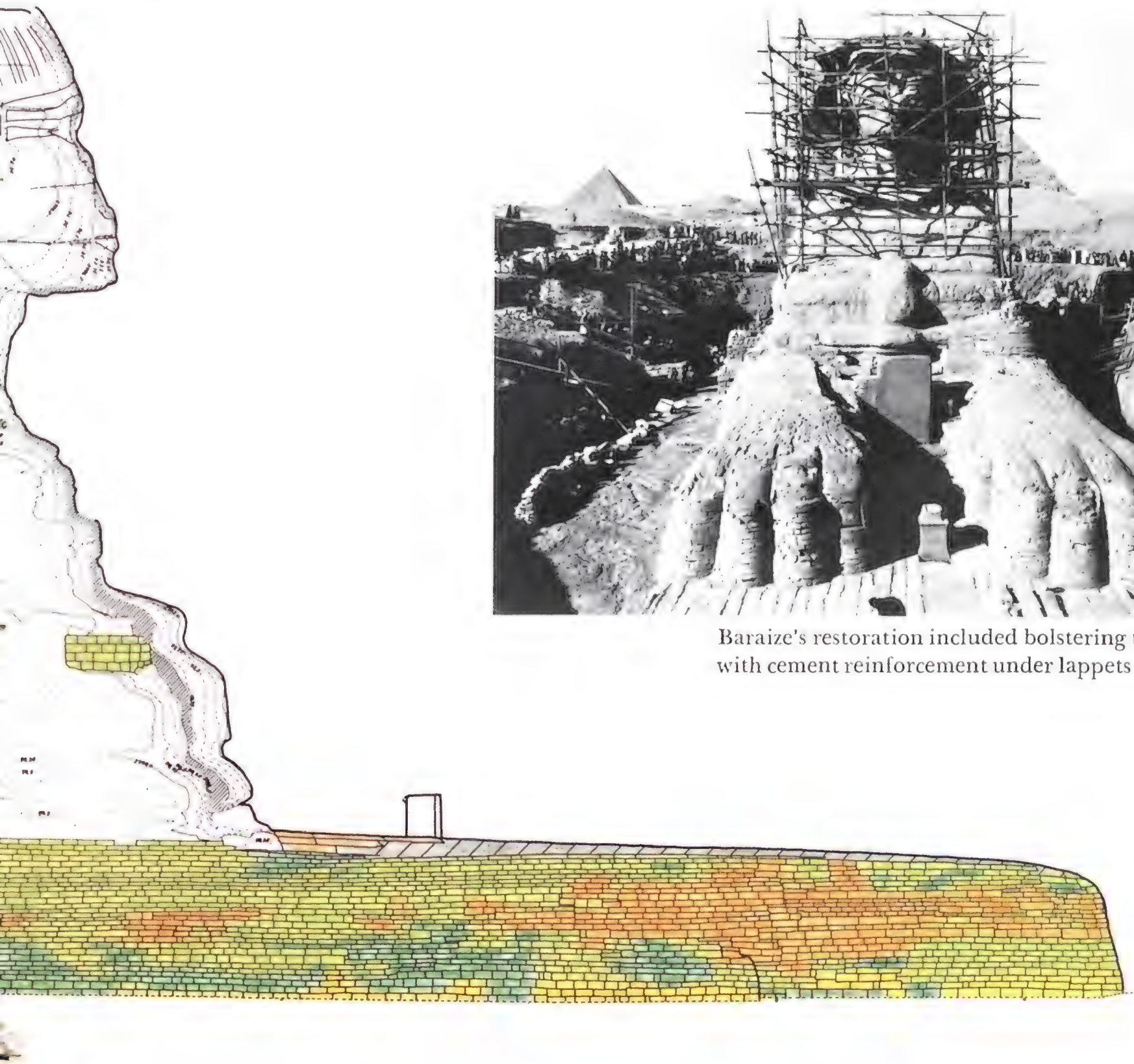
In 1818, Italian explorer Caviglia cleared drifted sand from in front of the Sphinx.

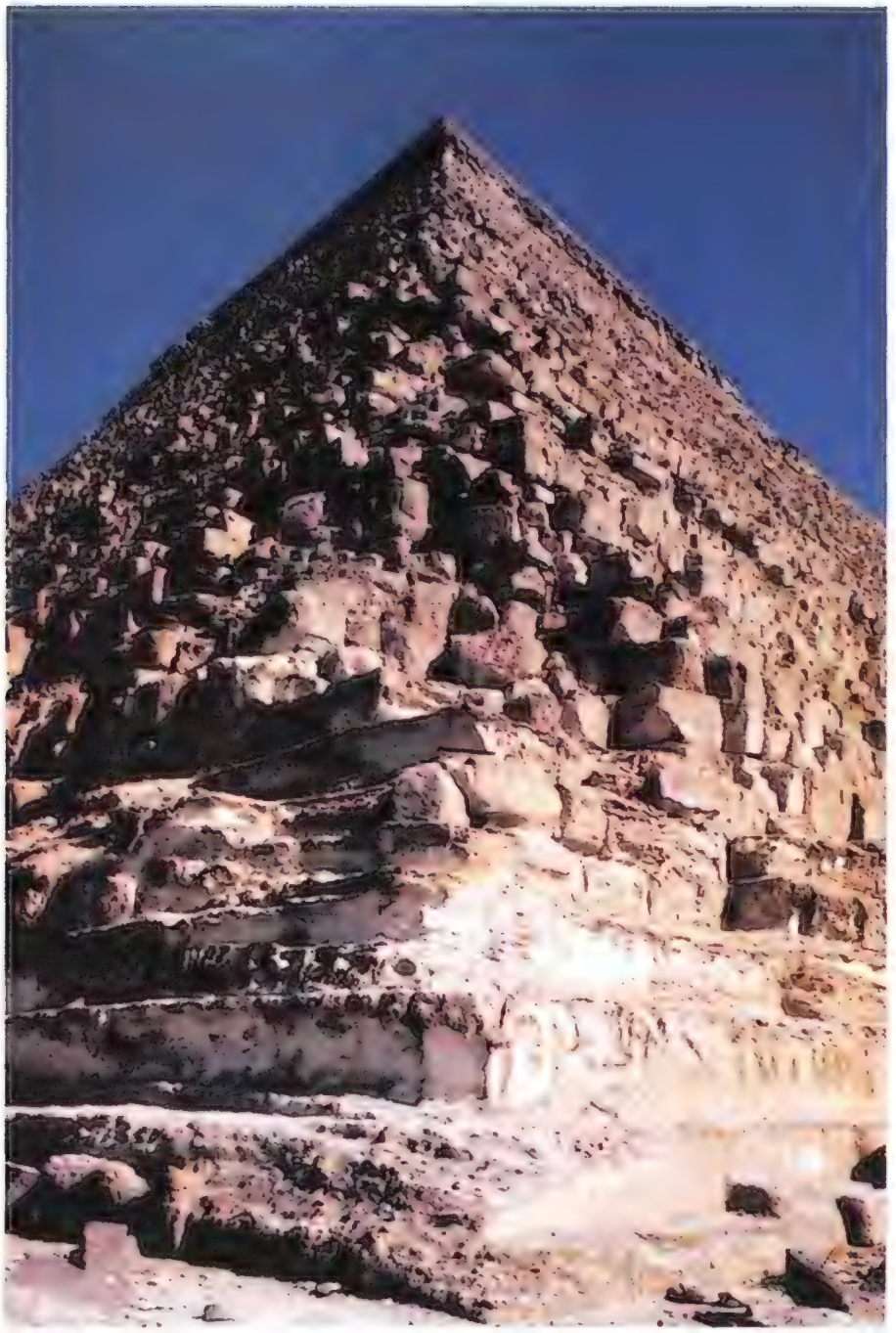


By mid-19th century, wood engravings were in vogue. Traces of the 1818 excavation are visible.

Photographers made romantic pictures such as this for tourists who flocked to plateau in the 1870s.

Baraize's restoration included bolstering the head with cement reinforcement under lappets of headdress.





Locally quarried blocks topped stepped bedrock core. Fine casing of Khafre, now missing, was imported.

Massive masonry wall may have bordered 4th Dynasty harbor and given access to administrators' village.

expedition led by K. Kromer dug there in the 1970s and found, under ten to 15 feet of debris, pottery, ashes, fishbones, fishhooks and even one two-inch limestone carving of a Sphinx, the spare-time doodle of a workman clever with his hands. There were also some crude walls and a few mud-seal impressions bearing the names of Khufu and his son Khafre.

Even earlier, in 1934, Egyptian archaeologist Selim Hassan sank trenches south of the big wall and found traces of mud-brick walls, a pavement set on a bed of limestone rubble, seals of both Khufu and Khafre, pottery vessels and flint utensils. On the basis of this physical evidence and on still-preserved workmen's villages at other sites, Lehner has placed an austere cell-like barracks in the bowl and a larger, more elaborate settlement behind the wall to the east. This town could have been home to permanent year-round master masons, architects and engineers.

Wraparound ramps for the pyramids

In the 1880s, when Sir Flinders Petrie studied the plateau, he believed the building stones had been imported because he could find no local quarries. For years now, Egyptologists have known the quarries were there, all right; they simply had filled up with debris and drifting sand. Using observation and local geology, Lehner places the main quarry for the Great Pyramid directly to the south of it. Here the natural stratification of the limestone formation called Mokattam would give workers stone easily cut into blocks, and the natural dip would facilitate construction of a ramp for hauling blocks to the pyramid site.

The most baffling of all questions has been how the Egyptians moved, to a height of 450 feet, building blocks averaging 2.5 tons and ranging up to 15. Scholars have suggested ramps sloping straight up to the pyramid. Many have thought they were made of Nile mud brick. Lehner rejects both the mud bricks and the straight ramp. "To be practical, a straight-slope ramp for the Great Pyramid would have to be nearly a mile long. Also, a mud-brick ramp would have left tons of debris. It just isn't there," he says. "What is there, and we find it in subsidiary ramps and embankments, is a combination of limestone chips, gypsum and a local calcareous clay called *tafla*. There are tons of this debris now filling up the quarries. This must be the remains of the ramp from the main quarry to the pyramid. It had to fit into the topography."

He suggests, "very tentatively at this point," a broad ramp up to the base of the pyramid, actually wrapping itself around the rising structure and growing right along with it. Workmen would drag the stones up, using water as a lubricant, set them in place one course at a time and then raise the ramp with each

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course of stones. Such a concept seems to fit the topography. The greater length and breadth of a straight-on ramp eventually would have covered the quarry itself. No ramp could have existed on the north, where there is a 120-foot drop in the terrain. On the east, Khufu was building the three smaller Queens' pyramids and, to the west, a field of mastabas, or rectangular tombs, for privileged members of the court. Only a wrap-around ramp set against the sides of the pyramid could have fit between it and the adjacent cemetery complexes. The Great Pyramid, at two-thirds of its height, contained 96 percent of its total bulk, and so the higher it grew, the shorter were the reaches of the ramp itself and the less material that had to be carried up.

Contrary to some early conjectures, Lehner and other Egyptologists are sure that the outer casing stones of the pyramid were put on as it rose, placed carefully but with the outer faces unfinished. Then, when the capstone was set, the workmen began moving downward, removing their ramp, dressing the casing stones to produce the smooth unbroken lines of the finished sides. Most of the casing has disappeared, having been stolen or fallen off over the years.

Dozens of scholars have tried to explain how the Egyptians measured the pyramid bases so accurately and were able to keep the structures level as they went up. Many versions have shown a grid of water-filled channels at ground level, covering the area selected for the base. By marking the waterline on the sides of the channels and then draining off the water, this theory has it, one could excavate the trenches to a uniform depth, remove the stone separating them and thereby create a level platform for the pyramid. This system, Lehner points out, would have been impossible for Khufu and Khafre because sticking up in their centers are huge cores of bedrock from 21 to 30 feet high. "There was no way they could grid those areas; they had to work around the outside," he says.

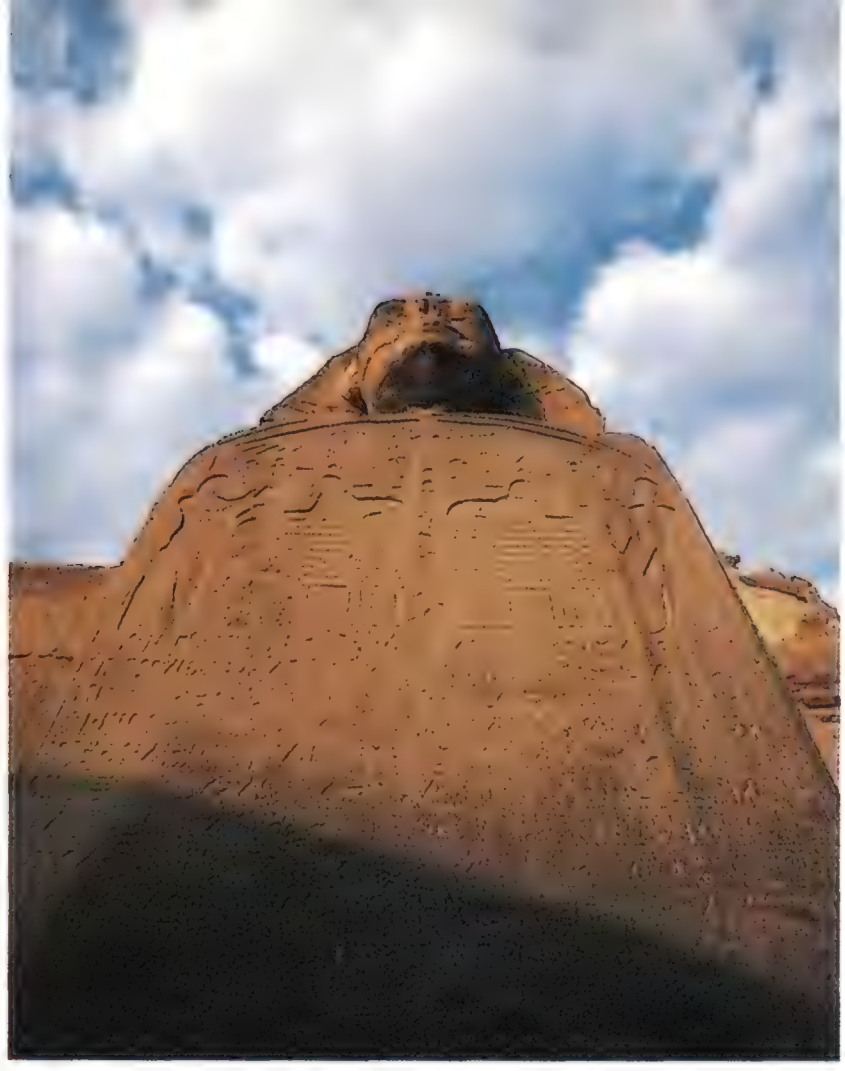
Found in area believed to be workers' settlement, tiny, crudely fashioned Sphinx has a winsome charm.

He has found a series of regularly spaced holes or sockets around the perimeter of the Great Pyramid, connected by depressions cut into the rock floor. He believes surveyors fixed stakes in the holes, let water run into the depressions, measured up and cut the stakes to true level. A line stretched along the tops would have formed a reference for leveling as well as for aligning and orienting the base. (Lehner believes Khafre's builders used a similar system, although the sockets-and-channels configuration differs somewhat.)

One day, while looking down from a perch on Khafre's pyramid, Lehner noticed trenches cut in the rock floor, in line with the diagonals of the pyramid. The trenches appear to be reservoirs fitted with a kind of sluice gate by which water was let into and out of the depressions as needed for the leveling operations.

"What is still a mystery," says Lehner with growing excitement, "is how the reference stakes and lines could have been transferred upward as the pyramid rose, since those around the base would have been buried under the massive construction ramps and dumps of debris. We have some possible explanations, but it needs more research." One of the aims of the survey is to clear the debris-filled depressions and holes and attempt to reconstruct the ancient survey system.

To attack other mysteries of the site, Lehner and Dr.



Stela in foreground was ordered by grateful Tuthmosis IV, who believed Sphinx had made him Egypt's ruler.

Paws of Sphinx were encased in current restoration; behind it are the pyramids of Khafre (left) and Khufu.

Robert Wenke, professor of prehistory and archaeology at the University of Washington, spent months crawling up and down the pyramids, winkling out bits of extraneous organic matter embedded in the mortar of the giant structures. "By radiocarbon dating this material, we are getting some early dates which may require a reevaluation of the traditional chronology," says Lehner. The ongoing sampling will yield even more information: analysis of charcoal fragments may reveal what type of trees or shrubs once existed near the now barren plateau. Excavations in the area of the various settlements could recover coprolites, which would indicate diet. Bits of wood, reed, bone, fragments of ancient pottery and tools would provide more clues to living and working conditions. "We need to sift a lot of sand and recover a lot more fragments," says the field director cheerfully.

All but ignored in the current mapping project is the most evocative of the monuments, the Pharaoh Khafre's sprawling, human-headed leonine Sphinx, crouched in the sand with a sunken temple below its paws. And yet it was this temple, and the Sphinx, that provided the first clues to unraveling the secrets of the plateau and inspired the ambitious mapping project.

Lehner had studied and excavated in Egypt for three years when, in 1979, he turned his attention to the Sphinx, which never had been examined thoroughly either geologically, architecturally or archaeologically. With the collaboration of Zahi Hawass and the American Research Center, Lehner set himself to the task.

He rounded up help from Dr. K. Lal Gauri, a stone conservationist for the University of Louisville; Thomas Aigner, a geologist and sedimentologist from the University of Tübingen in Germany; and Ulrich Kapp, surveyor and photogrammeter for the German Archaeological Institute in Cairo. They went to work. Their combined efforts resulted in the first-ever detailed mapping of the Sphinx, one elevation of which can be seen on pages 85-87.

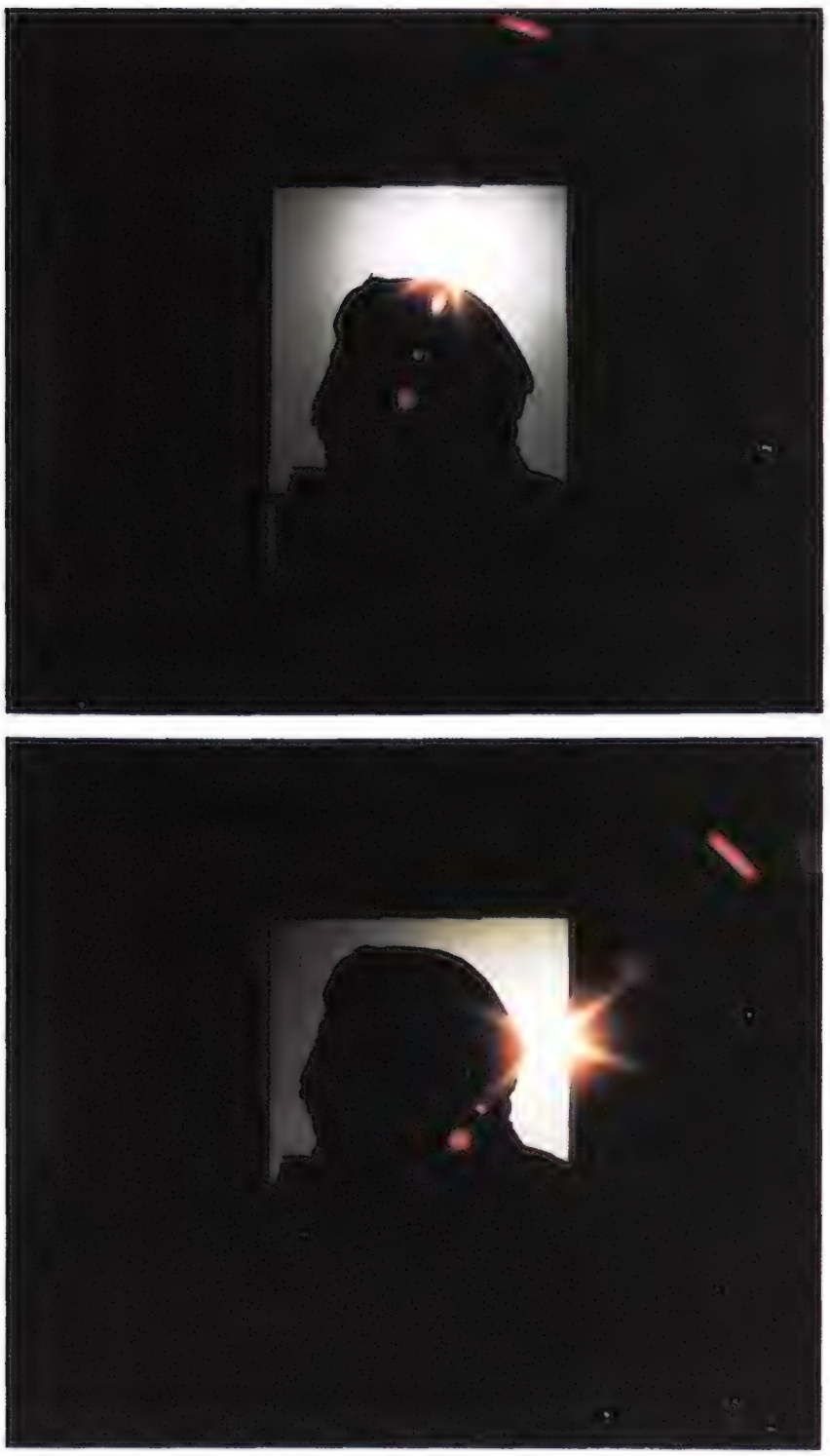
The top of its head now stands 78 feet higher than the bedrock upon which its temple stands, out below the paws. Since the figure was cut from the top down into the sedimentary bedrock, a prodigious amount of stone had to be hacked away all around it. Lehner and Co. believe that the quarrymen set aside enormous blocks to build the temple itself and hauled others up the slope to build Khafre's pyramid.

One simple clue, a yellowish band of claylike marl, proved an indispensable key. This band was clearly visible running through the Sphinx's natural bedrock shoulders; it also runs through the huge limestone blocks used to build the Sphinx temple and can also

be identified readily along the walls of the quarry.

"When you're dealing with blocks weighing up to 200 tons each, as these do, there isn't much chance to mix them up from quarry to temple walls," says Lehner. "It was clear we could trace these stones back to their quarry site, and trace others by their fossil content, their 'fossil fingerprints.' If we could do it for the Sphinx and its temple, then we should be able to do it with the pyramids and their quarries: unbuild them, in effect, and trace the stones back."

Once the geology and architecture of the Sphinx had been charted and digested, an age-old question arose: Why did the pharaoh Khafre want the Sphinx and its temple in the first place? It was traditional for a pharaoh to have a pyramid, a mortuary temple adjacent to it, and a "valley temple" on a lower level for various purification rites. But Khafre added the Sphinx and its temple, two features that were totally new and never to be repeated.



A setting sun traces outline of the Sphinx's head at winter solstice, viewed from an 18th Dynasty temple.

The temple was one of the last major monuments on the plateau to be discovered. It was excavated in the 1920s and '30s by Emile Baraize and Selim Hassan, but not studied in detail until 1967-70 when Herbert Ricke of the Swiss Archaeological Institute devoted himself to it. Ricke concluded that it was a solar temple, the oldest known in Egypt. He identified niche-sanctuaries on its east and west sides dedicated to the rising and setting sun, a colonnaded court with 24 massive pillars marking the 24 hours of the day, and ten or 12 statues of the pharaoh. Ricke further concluded that the Sphinx was not placed to guard the Giza necropolis, as some Egyptologists had surmised, but instead was a symbol of the sun-god himself, peering over the colonnade into the sanctuaries below.

Lehner accepts Ricke's identification of the temple as solar, but he believes that the Sphinx represents the pharaoh Khafre as Horus, the god of kingship, presenting offerings to the sun-god in the solar temple. If this is correct, then the Sphinx-and-temple complex may well represent the crucial transition, known to have taken place about the time of Khufu and Khafre, toward a solar-oriented religion. Before that time Horus, represented as a hawk, had been all powerful, but with the rise of the solar cult he had to make way for the sun-god Ra. Thus the Sphinx and its temple would for the first time embody the amalgam of old and new religious concepts.

Astonishing alignments with the sun

There are other haunting clues to a focus on the sun. When Lehner took the east-west temple axis as his base line when laying out a surveying grid for the area, he noted that it runs a bit south of the Sphinx, along the south side of the Khafre pyramid and then disappears into the horizon. Anyone looking westward from the temple's eastern sanctuary at the spring and autumn equinoxes will see the sun set at precisely that point. And so the temple axis refers to the astronomical midyear, when the setting sun strikes over the Sphinx's shoulder straight into the eastern sanctuary of the solar temple. (Another temple, which was constructed during the 18th Dynasty, shows an orientation toward the winter solstice.)

Two other astonishing alignments were revealed as the study went on, both involving the Egyptian hieroglyph *akhet*, which means "places where the sun rises and sets." The *akhet* is rendered as a sun between two mountains. Viewed from the Sphinx at the time of the summer solstice when the sun is at

its greatest distance north of the celestial equator, it sets directly between the pyramids of Khufu and Khafre, thus writing across the horizon an *akhet* "on the scale of acres," as Lehner says. By the time of the 18th Dynasty, when the Sphinx was 1,100 years old and buried up to its neck in sand, it had acquired the name of *Hor-em-akhet* (Horus-in-the-horizon). This is a clear reference both to Horus the god and the *akhet* sign, because anyone approaching from ancient Memphis would have seen the head of the Sphinx silhouetted between the two pyramids.

If Khafre ordered the alignment of his pyramid, his Sphinx and his solar temple to create these images with the sun, it indicates a high level of planning that has not been noted before.

What impresses Lehner most is how the Fourth Dynasty builders maintained their exquisite alignments while literally quarrying away the ground under their feet. "We know from study of the archaeoastronomy it is not so difficult to orient a structure to the equinox or to the solstice. But in the case of the Sphinx, the solar temple and the second pyramid, the surveyors had to project this line when the ground to be occupied by that complex presumably existed at the height of the Sphinx's head. They managed not to deviate from their survey reference lines as they quarried 70 feet down—quite an accomplishment."

It is Lehner's conviction that he and his team can figure out the builders' ingenious way of aligning the pyramids and temples by applying to the entire plateau the kind of meticulous study that they did on the Sphinx.

He has rounded up funding from Los Angeles realtor Bruce Ludwig, Yale University, General Dynamics, the Edgar Cayce Foundation and various other individuals. He also receives practical help from the Lietz Company of Overland Park, Kansas, which lends to new team member David Goodman the use of equipment to aid in the complex surveying and measuring.

Despite all the scientific exploration and extrapolation, Lehner's heart lies where that of many another observer has been. "It would be really neat if we can begin finding out about those people who did the work," he says. "How they lived, how they did it. You know, all those thousands who aren't mentioned in the inscriptions and the hieroglyphs. . . ."

When seen from Sphinx at summer solstice, the sun setting between pyramids of Khufu (right) and Khafre forms *akhet* hieroglyph, an allusion to cult of solar worship and to name of Great Pyramid, Akhty-Khufu.

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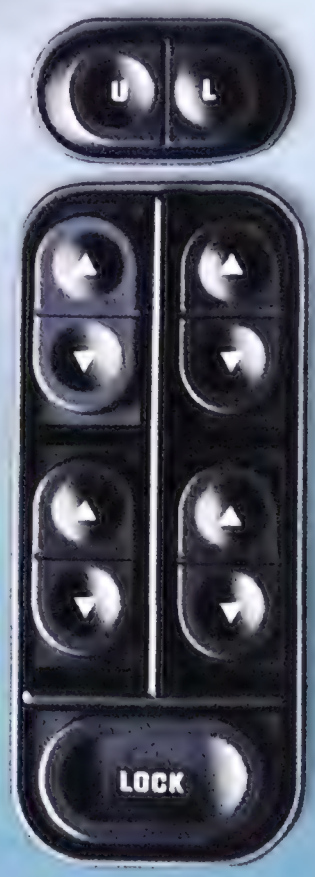

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By Doug Stewart

Modern designers still can't make the perfect chair

A seat combining comfort with beauty eludes the world's artists, architects, even engineers armed with computers

In his back-alley shop in East Greenville, Pennsylvania, Don Albinson, respected elder among chair designers, is holding forth on the subject of chairs. In particular, he is expressing his disdain for the latest flurry of high-priced chairs designed by avant-garde architects. "They tend to be sculptures you can sit on, if you're really determined to," he says. "I used to call a lot of the new stuff 'T-square-and-triangle furniture.' It's designed perfectly to hold a cardboard carton."

Albinson has been designing furniture for more than 40 years. He is a straight-talking, dirty-fingernails sort of craftsman with the pallid complexion of someone who puts in long hours in a machine shop. The shop in question is filled with huge spools of thread, power saws, industrial sewing machines, and tables covered with leather hides. "Designing is not drawing pictures," he explains.

Albinson is especially scornful of a series of plywood chairs designed by Postmodern architect Robert Venturi. Knoll International, where Albinson once worked as design director, recently introduced the line in a blaze of publicity. Venturi's chairs are flat, bright-colored parodies of handcrafted classics—a plywood Chippendale, a plywood Hepplewhite (above). Even a Knoll associate says they resemble chairs run over by a truck. New York's Museum of Modern Art, not waiting for the judgment of history, has acquired a set for its design collection. Albinson refers to the Venturi collection as "caricachairs." He says, "The people who can afford that stuff deserve it."

Robert Venturi's plywood chairs are modern versions of classic shapes: Chippendale, Hepplewhite (front).

Albinson's criticisms would be more persuasive were he not sitting in one of the ugliest chairs I've ever seen. It is a smallish, pale green fiberglass shell in the shape of an ice cream scoop with curving flanges on each side for armrests. The chair is a manufacturing prototype that Albinson crafted and produced nearly 40 years ago from a design by his mentor in the furniture business, the late architect and designer Charles Eames. The Eames shell chair has since become a ubiquitous element of airport and bowling-alley decor from coast to coast. Albinson's own chair has an additional bonus: a thicket of metal rods descending from the shell to an incongruous pair of wooden rockers. As Albinson

Contemporary Equa chair by Don Chadwick and Bill Stumpf is torture-tested in lab before production.

talks, he fidgets, rocks, and swivels violently in an apparent effort to find a comfortable position.

To Albinson, the perfect chair is a one-piece, molded-plastic seat that is easy to produce, easy to move, easy to clean and easy to pay for. In its time, the Eames shell chair tried to do all that, dispensing with the springs and cushions of traditional armchairs and using instead a thin, rock-hard surface that curved in an approximation of the human form. Unfortunately, the result is neither terribly comfortable nor, by today's standards, terribly attractive. In 1950, the Eames shell was revolutionary. Today, it's just kitsch—something you squirm in while waiting for your laundry to dry.

Designing a comfortable, pleasant-looking chair wouldn't strike most people as such a tall order. What

Eames associate Don Albinson sits on stackable chairs with his swivel and rocker at his feet. The six chairs pictured to the right represent milestones in endless process of redesign, a challenge that architect Mies van der Rohe found hard as planning new skyscraper.

Diamond chair, Harry Bertoia, 1952

Side chair, Frank Lloyd Wright, 1950

is a chair, after all, but a horizontal platform to keep one's rear end off the floor? Human beings are a delicate cargo, however, and chairs must treat them far more tenderly than a coffee table treats an ashtray. Nor are chairs designed just for sitting. In the rarefied world of architects and designers, in particular, the chair is a centerpiece for a room, an expression of esthetic dogma, a complement for a desk, a prop for parties, a symbol of authority and, yes, a support for cardboard cartons. The chair is, in sum, the quintessential design problem.

"All my life my legs have been banged up somewhere by the chairs I have designed," architect Frank Lloyd Wright confessed in 1953. Guests in Wright-designed homes tended to find themselves pitching forward onto the floor when they reached for the salt from their Wright-designed dining chairs, and the master himself on occasion sent his top-heavy dining chair at Taliesin crashing onto its back when he arose from the table. Wright was not alone in his frustration. Many of the luminaries of the architectural world—Marcel Breuer, Ludwig Mies van der Rohe, Le Corbusier, Eero Saarinen, Charles Eames—have been obsessed with building a decent chair. Mies once remarked that a skyscraper seemed almost easier to design than a good chair.

In ages past, sitting was a simpler activity (and a less often practiced one). Individual chairs were rare in medieval Europe. Kings had their thrones, and high clerics their ornately carved choir stalls, but everyone

Barcelona chair, Ludwig Mies van der Rohe, 1929

Wassily chair, Marcel Breuer, 1925

Molded plywood chair, Charles Eames, 1946

Coconut chair, George Nelson, 1957

In pursuit of the perfect chair

Balans chair improves sitting posture to avoid back problems, but some see it as "disciplinary furniture."

else sat on whatever surfaces presented themselves: windowsills, benches, low stools, overturned baskets. A painting of the French high court deliberating in 1458 depicts the robed justices sitting packed together on the floor.

The march of Western civilization seems to have been accompanied by a growing obsession with furniture. By the reign of Louis XIV, elegant seating had spread to the new leisure classes. High-priced upholsterers created armchairs padded with horsehair or feathers and covered in silk. In the early 19th century, springs were added. Chairs grew larger and bulkier. By the Victorian era in Europe, according to historian Siegfried Giedion, author of *Mechanization Takes Command*, "The seat and the whole chair appear to the naive eye as a complex of cushions somehow miraculously held together." He wrote: "Beneath [the upholstery], the woodwork decays like fallen trees obliterated beneath blankets of moss." A popular motif in late-19th-century paintings was the voluptuous nude reclining on equally voluptuous furniture.

If the overstuffed easy chair was the fin-de-siècle ideal in Europe, designers across the Atlantic had a different idea of seating perfection. Americans, makers of that ingenious sitting device, the rocking chair, considered chair design a task for the engineer, not the upholsterer. By the mid-1880s, a host of inventors were patenting convertible chairs of every description. There were rocking-chair cradles, piano-beds, and railroad seats that could be hoisted out of the way like dumbwaiters. The aim was convenience, not good looks. The impulse continues to be an American trademark. Recent gems from the drawing boards of American inventors include a wearable chair for hikers (p.102) and an all-in-one binocular stand/umbrella/folding seat for golf fans. One store offers a $1,400 recliner with built-in stereo and massager. Eyesores perhaps, but convenient ones.

Form takes a back seat to function

A group of architects in Europe following World War I rejected both of these approaches to seating—the chair as overstuffed set piece (frivolous and irrelevant) and the chair as machinery to sit in (ugly and overdesigned). These architects were members of the German Bauhaus and the Dutch de Stijl movements, and their motto was "form follows function." They used chairs as their manifestos, chairs being small enough for one person to build, vague enough to allow artistic license, but *chairs* nonetheless and thus nobler than art for art's sake.

The first of these object lessons was Dutchman Gerrit Rietveld's Red and Blue chair in 1918, a bizarre structure suggesting a Mondrian painting in three

Niels Diffrient reclines in his scientifically designed "ergonomic" chair, with levers for seat control.

In Diffrient's design lab, chair prototype has computer probes that measure precisely how sitter settles into it.

dimensions. Rietveld's intention was to reduce the chair to its absolute, no-nonsense mass-producible essence: a pair of plywood frames propped up by wooden struts. A critic called it "offensively, brutally simple" (whether with admiration or contempt is unclear).

Others followed suit. Le Corbusier brought out the optimistically named Grand Confort, five cushions in a cage of steel tubing. It looked terribly comfortable, critic Reyner Banham once noted, "But when you sit in it, it slowly slides you forward onto the floor with your knees up, and breaks your spine by reverse flexure in the process. Architects buy these chairs purely out of reverence for the name of the designer, admire them, but avoid sitting in them."

Little by little, even among Bauhaus diehards, form started getting the upper hand over function. Eleven years after the Red and Blue chair's debut, Mies unveiled his celebrated Barcelona chair, a modern-day throne designed for a quick ceremonial visit by the King of Spain to a world's fair pavilion. It was heavy, it was laborious and expensive to produce and its back curved the wrong way, but replicas soon became a fixture in the homes and offices of the cognoscenti. "When you saw that holy object on the sisal rug, you knew you were in a household where a fledgling architect and his young wife had sacrificed everything to bring the symbol of the godly mission into their home," Tom Wolfe wrote in *From Bauhaus to Our House*, recalling his days at Yale in the 1950s.

Chairs were becoming a way to make an architect's reputation. Certain chairs took on the status of revered works of art and were given titles like boats or estates: the Wassily chair, the Brno chair, the Eames chair, the Hardoy chair. "Somehow a chair would bring a designer more status, more recognition than if he'd done a whole building," says designer and critic George Nelson, now 77, himself the designer of several prize-winning chairs. "No one gets canonized for doing a sofa or the world's most beautiful coffee table," he notes, though he can't explain why.

After World War II, designers took to using chairs as a testing ground for new materials developed as part of the war effort. The new materials led to unexpected new shapes. The Eames "potato-chip" chair, with its curved plywood seat and back, resembled a Calder mobile on four spindly legs. The tapered plastic stems of Eero Saarinen's pedestal chairs have not aged quite so well—they call to mind the Jetsons' cartoon spaceship—but in 1955 they offered an end to the "slum of legs" blighting so many households. The inspiration for Harry Bertoia's popular Diamond chair of 1952 was a plastic-covered wire dishrack. The dishrack was probably only slightly less comfortable.

Chair designers today have grown more sophisticated and more subdued in their use of new technology. Much innovative chair design is now aimed at the white-collar office, and corporate buyers aren't interested in flights of fancy. In the office of the '80s, the watchword is ergonomics—the study of how to adapt machines to people—and the telltale sign of an ergonomically designed chair is an instruction manual. Unlike Don Albinson's one-piece ideal, ergonomic chairs tend to have a lot of moving parts: levers and knobs and, most recently, compressed-gas canisters for raising and lowering the seat.

"If you buy an automobile, you have to learn how to drive. If you buy a professional chair, you should have a lesson on how to use it," says Niels Diffrient, an

Mr. Stewart is a free-lance writer based in Newbury, Massachusetts. His last article for SMITHSONIAN *was on Airstream-trailer culture, in the December 1985 issue.*

industrial designer in Ridgefield, Connecticut, known for his scientific approach to chair design. Diffrient is a genial man with horn-rimmed glasses, a bow tie and the mild demeanor of a family doctor. As he shows me around the building housing his studio, we leapfrog from chair to ergonomic chair, popping levers and twisting knobs as we go (p. 101).

When Diffrient talks about sitting, he talks about pelvic cages and spinal disks and pounds of thrust, like some kind of rocket engineer. When he talks about what happens when the average person sits in a badly designed chair without moving, it sounds perfectly gruesome. Disrupted blood flow, painfully bent spines, crushed internal organs—"You'd think that he'd be dead in about five minutes," he says. The best chair is a bed, Diffrient concludes, which is why recliners like the Barcalounger and the La-Z-Boy are such perennial favorites. But beds aren't designed for working.

A typical Diffrient office chair has myriad seatback and headrest adjustments to suit the body of the worker and the task at hand. To figure out which part should move where, Diffrient has turned part of his studio into a sitter's laboratory. In one room is a test chair with a forest of wires sprouting from it. There are 30 computerized probes embedded in the seat and nearly as many in its back (p.101). During tests, the probes register how deeply into the chair the sitter actually settles. In the old days, Diffrient on occasion used a more low-tech approach: he poked knitting needles up through the cushions until the test subject said "When."

Diffrient admits that not everyone is ready for seat controls. Several years ago, he designed an airplane seat that included an inflatable cushion for lower-back support. Passengers ignored the feature and the airline eventually replaced the seats. Diffrient realized that since passengers seldom glance at the pamphlet explaining what to do in the event of a plane crash, he should have guessed they wouldn't bother with seat-inflation literature.

Earth Shoes of the chair world

A simpler approach to sitting is the Balans chair (p. 100) and its clones, Earth Shoes of the chair world. These are U-shaped, backless rocking stools in which the sitter half sits and half kneels, thereby forcing the spine into a healthful posture. Their designers tout the concept as, at long last, the ideal chair. Some people do indeed swear by them, notably young computer workers with bad backs. But when I spent a day in one, my shins soon ached. Whenever I leaned forward to talk on the phone, my feet fell asleep. And fidgeting was nearly impossible.

Even if the Balans chair were perfectly comfortable, it would have another mark against it. It is an ungainly structure—disciplinary furniture, one critic calls the genre—and an unspoken rule of well-designed chairs is that the people in them should appear gracefully at ease and in control. Getting stuck while inserting oneself in one's chair is unacceptable.

A "wearable chair" by Darcy Robert Bonner jr. straps to calves, extends up back of legs when walking.

According to architect and industrial designer Emilio Ambasz, the ideal chair must be more than an assemblage of cushions and struts and angles; to be appealing, it must provide psychological as well as physical comfort. "We probably spend five minutes a day doing concentrated mental work," he tells me as we try out chairs in his Greenwich Village office. "The rest of the time we all daydream. We may fancy ourselves the pilot of an intercontinental shuttle or a captain of industry." People prefer chairs that reinforce that self-image, he believes.

Ambasz is a dapper, sardonic Argentine who was once design curator of the Museum of Modern Art. He points out that the traditional executive chair is a potent symbol of authority—witness Abraham Lincoln in his marble armchair or the stone pharaohs of Abu Simbel. "The large executive chair elevates the sitter," he says. "It distances him. It protects the body. There is a tall back to rest this"—he cups his head gingerly in his hands—"and it is covered with the skin of some animal, preferably your predecessor."

Some chairmakers carry the quest for seating splen-

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Chairs in the Smithsonian collection include classic American types and an English Turned chair (left rear).

dor to its logical extreme. Pedestrian matters such as sittability, portability, stackability and affordability are irrelevant—what's important is a good throne. In a two-story loft in New York's SoHo district, sculptor Christopher Sproat builds chairs that have been categorized as electromythic, although he prefers the term Gothic futurism. In paint-stained corduroys and sneakers, he shows me around his furniture-filled loft as a flock of zebra finches dart about overhead.

At the four corners of the space stand huge, black wooden chairs, each one of them eight feet tall, reminding me of sentries that stood guard in an Egyptian temple (opposite). Near the center of the loft is a set of chairs with diamond-shaped swiveling backs, a black monolith chair whose back suggests a stylized cat, and a long, gilded bench shaped like a dragon. The chairs nearest the walls are covered with drop cloths in deference to the finches.

Sproat says he is trying to fashion a culture parallel to our own, using furniture to flesh out the details. "I've always been moved by ancient African and Egyptian art and the art of cultures that were complete, consistent esthetic entities," he says. "A lot of things today evoke a compressed middle class. There's no nobility left. All we have now is nouveau riche. Chairs like mine evoke an empire." People who sit in his chairs, he says, "will look like little children, or Lilliputians on someone else's throne."

The image of small children rattling around in enormous hard chairs may seem to fall drastically short of the seating ideal envisioned by the bulk of history's chairmakers, but in fact there is something to be said for this approach to seating. Adults may complain that their chairs are uncomfortable, but children rarely do. Young children tend to fidget and squirm too much to let their backs sag or their feet fall asleep.

To watch how they sat, I recently visited a classroom of elementary students playing computer games and I noticed a number of chair postures that furniture makers probably don't take into account. Engrossed in their games, the children explored their chair legs with the soles of their shoes or sat cross-legged on their seats. One boy punctuated both victories and defeats by stamping his feet in excitement. The youngest children, those whose feet dangled above the floor (disaster for an adult), either wrapped their feet and ankles around their chairs' legs or swung their legs forward and back as though pumping a swing. In between games, children hopped up and down from their chairs or duck-walked from chair to chair, eyes on the nearest screen. As a group, the children treated their chairs not as containers so much as reference points above which to keep their centers of gravity.

Adults could do well to follow their example, according to Mary Plumb Blade, a retired professor of mechanical engineering at Cooper Union and a researcher into the problem of sitting. "If you don't move, you quickly begin to lose calcium in your bones," she says. "A chair that fits you perfectly is probably damaging," she adds, noting that the form-fitting seats in NASA's first space capsules turned out to be terribly uncomfortable on the launching pad. "When I have to drive a long way, I put a board on the seat so I don't sink into the upholstery," she says.

Blade questions the whole idea of chairs with backs. When your back gets tired, she says, it's time to move. In Blade's view, any chair is fine for a short period and no chair is any good longer than that. She recommends perching as the best form of sitting. Rocking is second.

If chairs were intended as mere support structures, of course, their design would be a far simpler matter. But since the first tribal chieftain pulled up a log to elevate himself above his fellows, chairs have been more a symbol than an aid to survival. Our chairless ancestors probably spent most of their lives lying, squatting or running. They didn't need chairs and we probably don't either. "There are rocks that you can sit on perfectly comfortably," points out designer George Nelson, who likes to lean on fire hydrants. "It just happens that almost anything can be made to serve as a chair, so you've got a lot to work with."

Christopher Sproat designs his larger-than-life chairs to restore life's nobility, in "electromythic" style.

Royal Air Force pilot's wings and navigation tables were among wreckage of British planes in polders.

Kneeling in the soft dirt of a reclaimed polder, Arie van der Graaf examines pipe from B-17 wreck.

By Les Daly

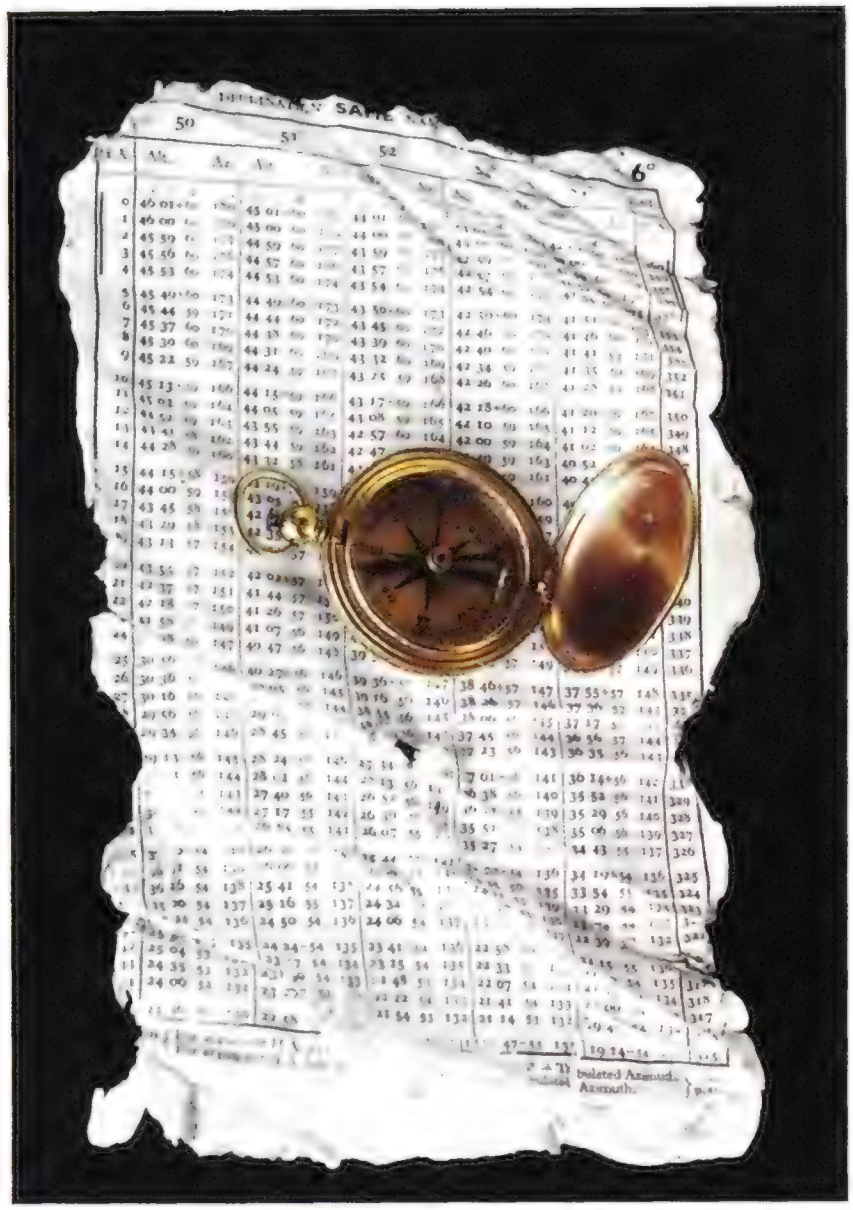
Archaeology with a heart in Holland's drained inland sea

Excavating planes that crashed in its waters during World War II, a Dutch team is helping old wounds to finally heal

"I remember that crash because it was at 3 o'clock on my wife's birthday on Easter Sunday in 1944," a Dutch farmer tells an "archaeologist," actually a Dutch government official. At that moment, he recalls, a flaming fighter plane plunged to Earth and buried itself in his farmland near the southeastern Zuider Zee dike. As unforgettable as that incident was, it was only one of thousands like it that shattered the days and nights of Holland for five years; in staggering fact, Dutch experts estimate that more than 7,000 aircraft crashed in the Netherlands or in Dutch waters during World War II. They were American, British, German, sometimes flown by Australians, Canadians, New Zealanders and others. Too frequently the pilots and crewmen vanished with their planes. They were listed with official certainty as "missing in action and presumed killed."

The Netherlands lies at the corner of the continent of Europe, perhaps the busiest corner in the world during World War II. The location made the Netherlands the direct air route between England and Germany. Much of the corridor passed above the huge inland body of water once called the Zuider Zee, and

He specializes in identifying crashed planes and tracking down the old records of their crews.



U.S. Air Force hand compass was sifted from mud during the 1982 excavation of B-24 Liberator.

referred to as the IJsselmeer since it was closed off from the North Sea by a dike built in 1932. It was particularly attractive as a wartime air route because a large body of water was naturally less well defended than a flight path over land would have been.

Thus for more than five years the skies of Holland were filled with planes; early in the war they were Germans attacking and occupying the Netherlands, later streaming westward to devastate Britain, and each time returning again across Holland to their bases in Germany. Later still, as the momentum of war shifted, British, American, Canadian and other Allied fighters and bombers flew day and night above the Netherlands through German fighter squadrons and antiaircraft fire to strategic raids on Germany. Then they passed across Holland again, through more fighters and gunfire, on their way back to England. Thousands of those aircraft, on both sides, never reached home.

The enormity of 7,000 lost aircraft is almost impossible to comprehend. Consider this: the total fighter and bomber combat force of the U.S. Air Force today amounts to about 3,400 airplanes. To put it another way, the crash of 7,000 aircraft would mean that every square mile of the entire state of New Jersey would have shaken to the impact of a downed plane.

It is well known, of course, that for hundreds of years the Dutch have been draining, drying and developing livable land from their inland seabed. In the past 25 years, however, they have recovered from the mud of the land they "created" the wreckage of 178 World War II aircraft. With these aircraft were the identifiable remains of 72 crewmen; for about 40 years each had been listed only as "missing in action." They were American, British, Canadian; many were German.

The "old lands" of the Netherlands had largely been scoured already, since most aircraft that had crashed on land during the war had been dealt with by the occupying Germans. However, in the 1950s and '60s, as the east and southeast portions of the IJsselmeer were drained to form large "new lands," called polders, more wreckage emerged from the sea bottom. Aircraft and pieces of aircraft lay in the path of development of the new lands—an obstruction and, in fact, a danger.

Color photographs by Bryan and Cherry Alexander

The Dutch recover crashed planes

If there were any doubt that these remains of World War II posed unusual problems, they were dispelled in 1960 when a group of Boy Scouts near the town of Kampen pursued an unprecedented class of merit badge. The industrious Scouts hauled away the tail-turret machine guns and 700 rounds of ammunition from a British Wellington bomber, and restored them to working condition.

"We thought this was a bit too dangerous," relates Col. Arie P. de Jong of the Royal Netherlands Air Force and now an official of the Ministry of Defense. Only a few weeks earlier, an Air Force jet fighter had crashed into the IJsselmeer, and the civilian Ministry of Traffic and Waterways had asked the Air Force to clean up the site. They did, and it was immediately apparent to the government that the Air Force was better trained and equipped than any other agency to cope with the older wrecks as well. By the end of 1960, the Air Force's crash and recovery specialists were given permanent responsibility for safe removal of all old airplane wreckage, with Arie de Jong as their leader.

Since that time, as reclamation has progressed, the Air Force team has been kept busy. The two polders most recently reclaimed from the IJsselmeer together cover about 735 square miles, an area comparable to New York City. They look more like North Dakota, and on Holland's scale they are vast. In a country well sprinkled with farmhouses, villages and little roads that seem to stagger back and forth for the sheer joy of it, the polders are for the most part sparsely inhabited farmland, eerily flat and open, with straight roads running to the sky. Holland is the most densely populated country in Europe and the sudden appearance of emptiness is unsettling. The Dutch call the polders the "land of endless horizons." The phrase is picturesquely accurate. But at the same time the word "endless" seems as artificial and out of place as the "new lands" themselves in a country that you can drive across in a few hours.

In the midst of the polder farmland, the Dutch have been building sleek, cool concrete towns. They come complete with shopping centers, parking lots, underground utilities and sports complexes; on the flat polder lands they unavoidably bring to mind rows of little houses and hotels on "Boardwalk" and "Park Place." And they frequently stand where aircraft have fallen, bringing in the Air Force specialists. "A grazing cow doesn't have any trouble with an aircraft that is five or six feet below the ground," says Gerrie J. Zwanenburg, who is currently head of the recovery team. "But when you start building houses, that's an entirely different story."

When the Air Force recovery team was formed, the first thing they did, with the cooperation of American, British and German authorities, was to compile a virtual encyclopedia of nearly every aircraft thought to have crashed in Holland. They concede, ruefully, that the German records are the best—"*deutsch greundlich*," a Dutch expression that refers to something being done "with great thoroughness." British records are also reliable, but often end simply with "nothing heard of this aircraft after takeoff," leaving the Dutch, as they say, "in the blind." Americans, they will tell

Flak-damaged B-24 bomber, burning in a field in 1944, was one of 7,000 planes downed over Holland.

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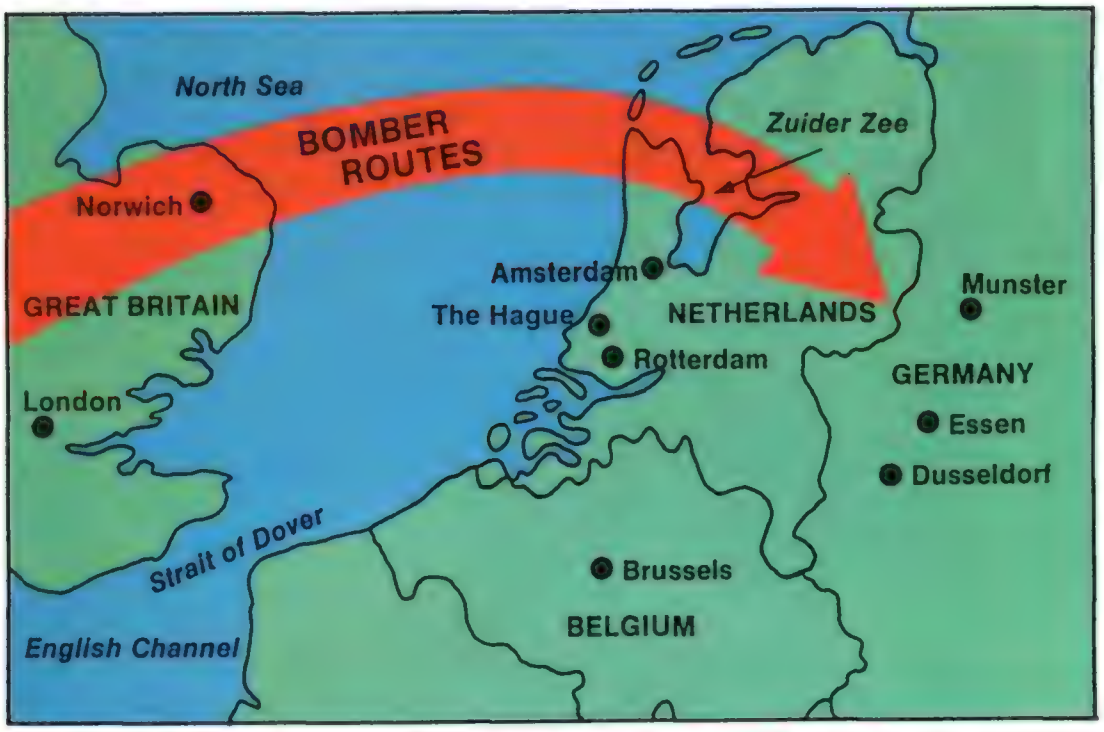
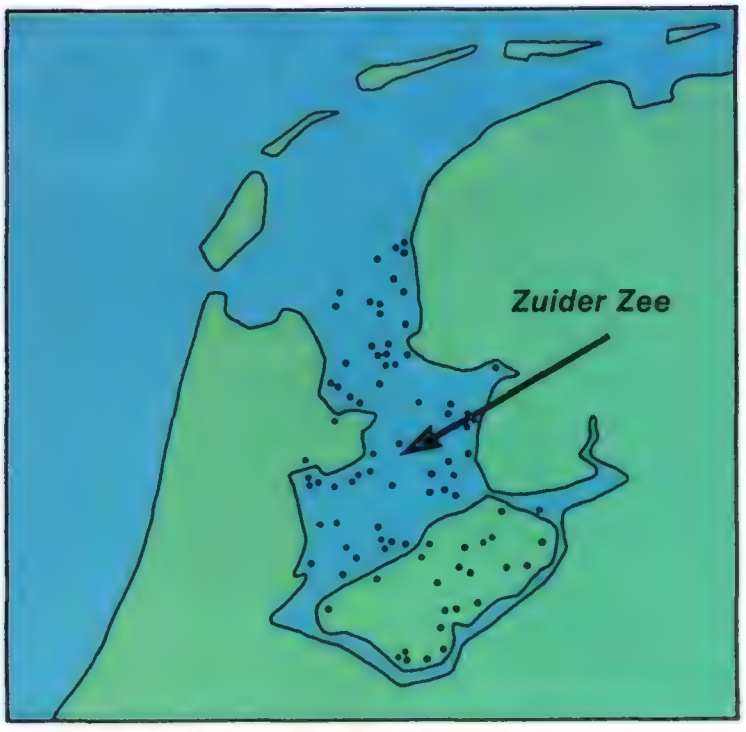


British and American bomber formations often flew over less-defended Zuider Zee to German targets.



On map of partially reclaimed Zuider Zee, dots mark where planes were found by draining or by fishermen.

you amiably, often were unclear about the difference between the Netherlands, Belgium and Germany and "if they say it went down in Holland it might well have been Copenhagen."

These records have become the backbone of the recovery operation, explains Zwanenburg, whose office is at a Dutch air base in the small town of Zeist, not far from Utrecht. His chief objet d'art there is a twin-barrel machine gun he recovered from a downed German Messerschmitt 110 night fighter; he often uses it as an armrest while talking about his work.

"When I hear a report of someone coming upon an aircraft, I go out there with my metal locator," says Zwanenburg with the deliberateness of a plumber being called to fix a pipe. "I check my records to see who was going where and when and what they lost. Then I get my team, maybe eight or ten fellows, perhaps with cranes, bulldozers; maybe with teaspoons. Sometimes we need two or three demolition experts, sometimes medical experts."

The "contemporary archaeologists" also seek additional information in the area where the crash occurred, often finding eyewitnesses with remarkable memories who can provide invaluable details, like the farmer who recalled the crash on his wife's birthday 35 years earlier. Before the recovery operation even begins, they have usually already established which aircraft it is and whether it is likely to be a salvage job alone or one that will involve demolition experts (there is almost always ammunition and frequently there are unexploded bombs).

"In fact, if the plane is a bomber the first question we must answer is whether it was on the way to a target, or on the way home," says Zwanenburg. "We need to know if it had dropped its bombs or whether it crashed with the bombs aboard. And even then, it might have had a hang-up, a bomb that did not release." He pauses thoughtfully. "If you know you are working on top of four 1,000-pounders," he adds wryly, "then you would rather do it with a small spade instead of two big cranes."

There was, for example, the excavation in 1973 of an American B-17 that had crashed with "a whole load" of 500-pound bombs. Colonel de Jong, who has never quit working with the recovery team although he no longer heads it, wanted to know the ignition time of the fuses and asked for help from the U.S. Air Attaché at the embassy in The Hague. "He got us a very fast answer; the timing was one-fortieth of a second!" de Jong recalls today with still-lingering respect for both the promptness of the answer and the hastiness of the fuses. Further, the mechanisms had been immersed in mud and water for 30 years or so, with uncertain effects. "Knowing those facts in advance determines whether you will have a fast recovery or a very slow and careful one," he points out matter of factly. "We have never had an accident—knock on wood," he adds, tapping the table purposefully.

It is rare that an aircraft hits the water or the ground and remains intact. "Aircraft are designed to fly through the air and are really quite fragile; hitting land or water is like hitting a concrete wall," explains

The author, a frequent contributor to these pages, wrote about cave dwellers in the June 1983 issue and solar dream houses in September 1981.

The Spirit of America

Mabry Mill, Virginia by Clyde H. Smith

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Old Grand-Dad

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Col. Arie de Jong, who headed the recovery team when it formed in 1960, still works with the group today.

Gerrie Zwanenburg is now the team leader; when wreck is found, he heads to site with his metal detector.

de Jong. "The engines and the guns are usually the most durable items."

But not always. A half-filled bottle of eau de cologne was found in one aircraft, with a still strong fragrance. The manufacturer managed to acquire it "in the interests of research," an officer recalls, but used it instead in advertising. Functioning fountain pens and legible diaries, cards and letters have been found after more than 30 years. Film from mud-encased cameras was developed and produced recognizable images of raids over Germany. One American aircraft yielded a pair of silk stockings, "obviously a souvenir of better times," de Jong speculates. "At the moment we found them, in the midst of thinking about a wartime operation, it was a surprise."

It is indeed like an archaeological expedition, and the thrill of pursuit is contagious among the team members. For the veterans it is a source of technical and historical interest, and considerable personal satisfaction. For the 19- and 20-year-old enlisted airmen, wearing rubber hip boots to work in the cold wet mud, it becomes a sort of "gold fever" and irresistible. "As soon as they see a piece of an airplane, it turns into a challenge and they want to know more about it and what else is there," says de Jong. Routine coffee breaks are ignored by the men and the digging goes on until darkness despite the regular halt at the end of the working day.

The bed of the IJsselmeer is dark gray clay, the color of lifeless lunar rocks. Beneath the clay is sand. Civilians who visit the site are at first repelled by the gray mud and the cold water. After a few minutes, they ask to put on boots and take part in the excavation. The "fever" infects even the coolest observers who, like the team members themselves, are moved when a hand compass or a good-luck charm is sieved out of mud at the site of a wreck.

Unearthing old planes, reopening old wounds

From the beginning, the Dutch were aware that excavating the long-submerged planes created a poignant dilemma. Unearthing old planes also involved reopening old wounds as crew members once labeled missing in action were identified. At first, the Dutch were not anxious to enter the emotional unknowns among the families of men missing for so many years, hesitant to disturb old scars with new discoveries. "From our side, we were reluctant to give details, saying, 'Well, perhaps that is not decent; that should not be done,' telling how their beloved brother or son or husband spent his last seconds," explains de Jong.

"But much to our amazement, in all cases so far, and there have been hundreds of cases, people *ask*," he says. "I think it is the certainty, the technical certainty that

In the field, van der Graaf (left), Zwanenburg (third from right) and others recover Stirling prop.

Kent Miller (front, third from left) and Charlie Taylor (front, at left) were aboard an ill-fated B-24.

turns out to overrule their sensitivities. Even after this long period, people without exception are eager to know what happened and it satisfies them and is a consolation . . . no one ever says they don't want to know," he says reflectively. "It is something we had to learn."

Gene Miller agrees. Now retired and living in Florida, 11 years ago he was president of the Viking Glass Company in New Martinsville, West Virginia. "I was in my office one day and my secretary came in and told me there was a major who wanted to see me," he remembers. "When the officer came in, he introduced himself and immediately wanted to verify that I was Kent Miller's brother.

"The first thing I said was, 'I think I'd better sit down,' " Miller recalls. "I knew something had turned up about Kent, and I wanted to know." But Miller was shocked when the officer told him that after so many years, Kent's remains had been found. Miller then called his sister, Janet, and said, "If you're standing you'd better sit down, too." Once he had told her the news, he adds, "She started crying. She didn't know whether to be sad or glad."

The last time Miller had seen his brother was just before Kent went overseas. Kent had flown low in his bomber and buzzed the glass factory where Gene and his father were working. They had looked up and waved good-bye. The fledgling pilot was 20 years old.

According to official records, Kent Miller had been the pilot of a B-24H Liberator bomber, serial number 427638, that crashed into Holland's inland sea three days before Christmas in 1943. Four crewmen bailed out and later died. One, the copilot, Charlie Taylor, survived the crash-landing and was captured. Five, including Kent Miller, were declared missing in action.

Three decades later, the Dutch built dikes and began draining the polder that would be known as South Flevoland. The water receded about an inch a day and as it subsided to a depth of about two feet, "something that looked like a piece of white wood" emerged. Enlarged photographs revealed it to be an aircraft wing with a U.S. Army Air Forces insignia.

When the water had fully drained, the Dutch built a causeway across the mud and excavated what turned out to be a B-24 bomber, largely intact. Identification expert Arie van der Graaf and his Dutch colleagues worked with American authorities to track down the records of the five crew members who had not bailed out. Among them was Kent Miller, missing in action for 32 years.

Gene Miller and his sister were grateful to finally know what had happened to their brother. When a loved one is missing in action, Miller says today, "you may be 99 percent sure, but with no actual proof you think there's a chance they're alive and you always wonder. Knowing the truth at first made us sad; but in the long run it put our minds at ease."

Charlie Taylor, who had been the copilot on that fatal flight with Kent Miller, was luckier than his pilot. When their plane hit the 20-foot-deep water on that cold and cloudy December afternoon, its nose broke

off right next to the copilot's seat. Taylor fought his way out of the plane, climbed onto a wing and passed out. The next thing he knew he'd been picked up by the Germans. He never knew what had happened to his crewmates.

Charlie Taylor was astounded when in April 1975 he received a phone call at his home in Scotch Plains, New Jersey, from the Netherlands. They had found the plane in which he went down, the caller said; the remains of five of his fellow crew members had also been found inside the wreck. Soon, Gerrie Zwanenburg and Taylor were in direct contact. "Were there any bombs on the plane?" Zwanenburg asked him. "No," replied Taylor; "we dropped them all over Munster."

That October, Taylor flew over to the Netherlands, where Zwanenburg met him and took him to see the plane. They drove out along a dike, walked a quarter-mile on a sand road and then climbed onto a small pontoon raft that took them to the edge of the giant camouflage-green hulk. "Zwanenburg took me to the top of the fuselage," Taylor relates today. "He showed me where the armor plate had buckled and closed the escape hatch behind the pilot's seat, which is apparently what prevented anyone else from getting out." Taylor had long wondered why he had apparently been the only one to escape, and now he understood.

Taylor realized how lucky he'd been. "As we were walking on the plane I thought—here are the five bodies, still in here; it really shook me up," he says. "They were a great bunch of fellows. I was lucky to get out."

The Dutch still get requests from families in many countries asking for information and in some cases for a special recovery effort for an aircraft in which a man went down. "We need to know the precise location of an aircraft that is still carrying missing aircrew," says de Jong a little apologetically. He is a man who carries his responsibility heavily, who is aware that there are still too many anxious, hoping families somehow counting on him and his colleagues.

"If we thought there was a crewman and knew the precise location we would try to tackle the job, unless it was an impossible location, in the North Sea or in a busy shipping lane," he says. "But the majority of these simply cannot be done because we know too little. Sometimes the family is not even sure it is in the Netherlands."

On the whole, the recovery operation is an endeavor of extraordinary dedication and sometimes mystical coincidence. When aircraft and crew members have been recovered, the Dutch have sometimes found next of kin through advertisements published by the British Ministry of Defence in newspapers in England and in Canada. De Jong remembers receiving a letter from an airman in Dublin asking about his Wellington bomber that had crashed 37 years earlier. The letter was received in his office on the day that the Wellington was uncovered.

On another occasion, a Dutch farmer told a major newspaper that he would like to know the identity of a pilot who had crashed fatally on his farmland, so that he could locate and talk with the pilot's family. At almost the same time, the widow of that pilot was writing to Dutch officials from Brussels, hoping to establish where and how her husband died.

"I telephoned her to tell her the news before she read about it in the newspaper, and she fainted on the telephone," says de Jong. "There is a strange sort of coincidental luck, or possibly even more than that, which I cannot explain. But there is something beyond our own capabilities that plays a role in what we are doing."

Pilot Kent Miller did not survive plane crash into the Zuider Zee; his remains were found 32 years later.

Personal items, navigational equipment excavated from downed American planes form eloquent still life.

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By Ellen Ruppel Shell

An auction where horses bring more than Rembrandts

At the Keeneland, Kentucky, yearling sales, Arab sheikhs and European syndicates bid millions for the top American thoroughbreds

In preauction ritual, prospective bidders look over some of the yearlings to be offered at Keeneland sales.

Lexington, Kentucky, is no one's idea of a hot spot. It does not have what you'd call a truly luxurious hotel, and the restaurants tend toward barbecue. There are no gambling casinos, and on Sunday nights no one will sell you a glass of wine, let alone a Scotch and soda. But in mid-July this quiet college town becomes as important a stop on many jet-setting itineraries as Monaco or Saint-Tropez. That is when Lexington plays host to the Keeneland Selected Yearling Sale, the world's most prestigious horse auction.

The Keeneland Selected Yearling Sale is to Lexington what Mardi Gras is to New Orleans. The airport, tiny Blue Grass Field, clogs with private jets from Texas, California, London and the Arabian peninsula. Television sets flicker in the backseats of stretch limousines cruising in air-conditioned anonymity between downtown and the auction pavilion. The air thickens with foreign accents consulting in hushed tones about horses with exotic but vaguely familiar names, horses worth more than a Rembrandt.

And then, of course, there are the parties—dozens of them. The locals, famous for their hospitality, throw their doors open wide, inviting as many as a thousand visitors in at a clip. Inside there are no paper plates or plastic cups, no sorry trays of chips and dip or bowls of watered-down punch. When Kentucky horse farmers throw a party they mean business—they don't expect to make friends with prospective customers over a dried-out wheel of Brie.

Take Tom Gentry, owner of one of Lexington's most successful thoroughbred breeding and selling operations. A chunky man with what can only be called an unsophisticated taste in clothes, Gentry does not have the look of polished prosperity one would expect of Lexington's leading host. But to be excluded from Gentry's annual bash come Keeneland-time is to suffer the ultimate social snub—his parties are legendary and he's got the newspaper clippings to prove it.

Last year Gentry decided to go all out with an exclu-

As buyers survey the 306 horses in 24 barns, owners and grooms lead yearlings forth to display fine points.

sive little black-tie affair for 800 rich, famous or, at the very least, influential guests. The road (it could hardly be called a driveway) leading to his home was lit with torches, no doubt put there to encourage the anticipation of an Olympian affair. A platoon of tuxedoed guards stood watch to evict the inevitable gate crashers, a duty they performed with such rigor that even a hapless cab driver arriving to pick up a guest was turned back for lack of an invitation. But neither the caviar and lobster-tail hors d'oeuvres, nor the Las Vegas-style entertainment, nor the roving clumps of TV personalities and dazzlingly dressed millionaires could disguise the real purpose of the event, which was to drum up customers for Gentry's stable of magnificent thoroughbreds.

That's why Alessandro, scion of an aristocratic Italian family, declined to attend—he doesn't enjoy mixing business with pleasure, and for him Keeneland is

Photographs by William Strode

Crowd packs Keeneland sales arena as auctioneer takes bids on colt that is grandson of Northern Dancer.

At Tom Gentry's barn in Keeneland, waiter serves drinks in tumblers that bear his blue-and-gold silks.

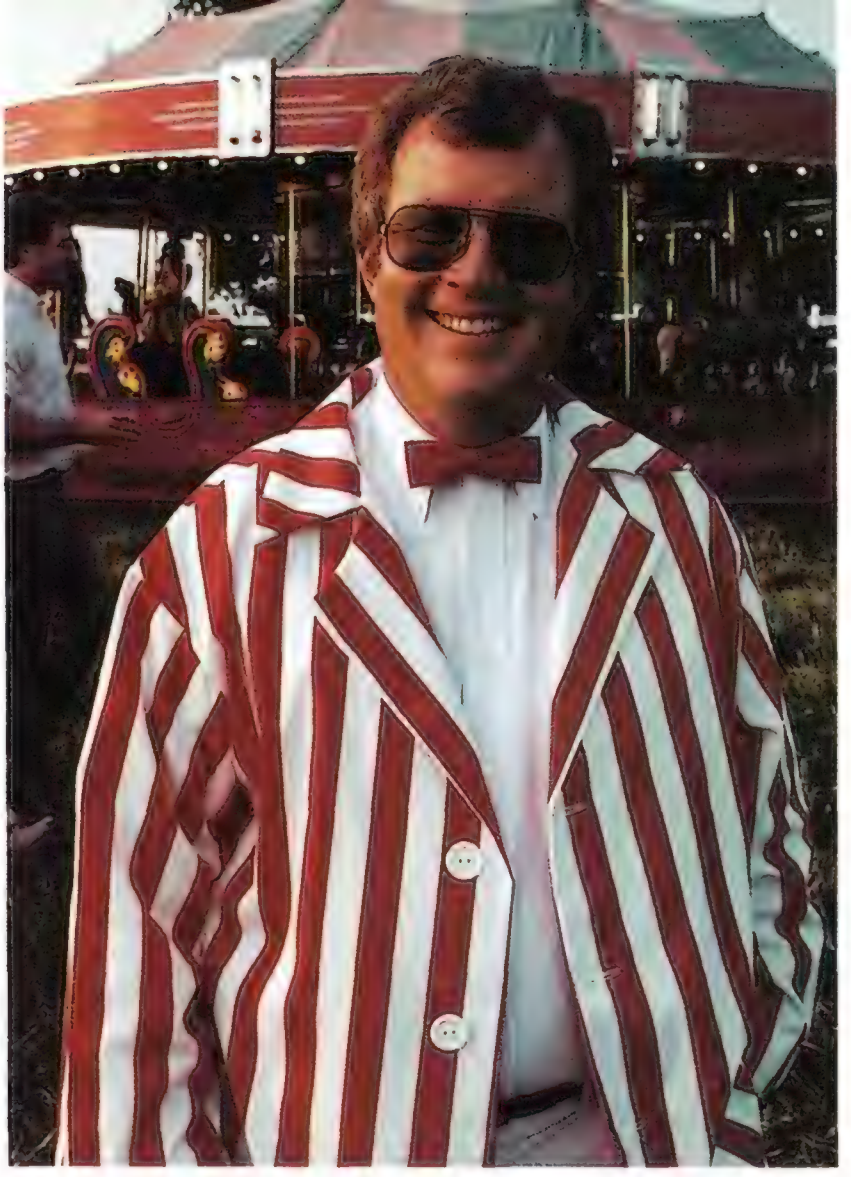
100 percent business. Dressed impeccably in designer sports clothes, Alessandro waits in the lobby of Lexington's best hotel for a few colleagues to join him for dinner. He has come to Lexington to buy several yearlings for his father's horse farm near Rome. Through a translator he says he expects to spend no more than two and a half million dollars. That will not be enough to buy him the horses he really wants, he says, but perhaps he will be lucky and get his third or fourth choices. Italians, he explains, prefer not to compete with buyers who do not set limits—buyers who will bid on a horse no matter what its price. He has, he says, learned patience and moderation. He bows, turns on his heel and heads toward the restaurant, where he will not salute his fellows with a glass of champagne. At 12 years of age, Alessandro might be old enough to spend two and a half million dollars in Kentucky, but he is not old enough to order spirits there.

Few are as sanguine as Alessandro when it comes to dealing with the disappointment of losing the bid on a much-wanted horse, but many share his dilemma. The best horses at Keeneland force the bidding so high so quickly that most would-be buyers can only gasp and shake their heads. Even the auctioneer seems astounded by the numbers, which flash in yellow neon from an overhead monitor as they're bid. Could this be real money that's changing hands?

The yearling auction transforms Keeneland Race Course, a sprawling 441-acre expanse of barns, racetracks, grassland and tobacco fields nestled between horse farms and an airport, into a glittering Disney World of possibility. Moguls, potentates and the just plain curious come days in advance to ogle the merchandise: slender, gleaming colts and fillies that have never borne a saddle, let alone entered a starting gate. Every one of these horses, it is claimed by their owners, has the stuff to become next year's Secretariat or Seattle Slew. This is not entirely wishful speaking. No horse gets to the Keeneland auction without an impeccable pedigree and the look of a winner—only about 300 of the estimated 50,000 thoroughbreds born each year make the grade. Those that don't are sold at lesser sales, sales where one can still buy a horse for less than a year's wages. Those selected are treated like the potentially priceless objects they have just proved themselves to be. They are kept inside during the day and allowed to run free at night to protect them from sunburn. Their hooves are polished, their manes trimmed and their coats rubbed to what can only be called a patina. Their stalls seem as clean as a hospital intensive-care unit and their every need is attended to by a bevy of grooms, some hired specially for the event. Their owners will claim they are treated better than most people. This is not an exaggeration—not many

Ellen Ruppel Shell is a free-lance writer and frequent SMITHSONIAN *contributor. She wrote on the couple who make national sports schedules in February 1985.*

Only two minutes into bidding, monitor shows price at $10.7 million, and battle for the colt is not over.



Gentry hosts Keeneland's most prestigious party; its themes change—one year, a carnival with carousel.

people sleep in bedrooms paneled in solid mahogany.

The Wednesday before the Monday sale the horses are transferred from their home stable to the Keeneland stalls. The stalls are laid out in a series of barns which stand in neat rows starting just behind the auction pavilion. The barn area is surprisingly quiet and neat, smelling only of fresh hay and clean straw. It's not uncommon to find three grooms in a stall with a single horse, raking out its bed, brushing its flanks, rubbing it down or just sitting there in silent communion.

On Saturday the promenade begins. Hundreds of people stroll from barn to barn, sipping free champagne and frozen daiquiris, chatting with old friends and, upon occasion, looking at a horse. There are enough gems glittering from throats, wrists, earlobes and fingers to keep an international jewel thief busy for weeks, but otherwise the dress is distinctly casual, a common motif being cotton sport shirt (albeit custom-made and monogrammed) with khaki trousers or floral-patterned skirt complete with a web belt and Topsiders or tassel loafers. Though it's impossible to tell the buyers from the gawkers (or "tire kickers," as they're called by the cognoscenti), anyone with the least interest in looking official carries a copy of the Keeneland bible, a 300-plus-page catalog that details the pedigree of every yearling at the sale. These brief family trees can be augmented with still more detailed computer-generated reports provided free for the asking in the sales pavilion. Champions, it is said, beget champions, and the horses with the loftiest pedigrees are dragged from their stalls to be shown so often that they tramp ruts in the grass.

The display of a yearling thoroughbred, not always a cooperative creature, is an art unto itself. It is not merely led from its stall, paraded in front of a prospective buyer and led back. This is the last chance buyers will have to take a close look at an animal they may well lose their shirts on, and many of them make the most of it. Veterinarians, distinguished by the stethoscopes that adorn their necks like string ties, do on-the-spot checkups, while trainers scrutinize every nuance of the horse's gait and stance. Meanwhile, the seller carries on a running commentary detailing the horse's wonderful pedigree, kindly disposition and superior intelligence. He or his groom may walk beside the animal, flicking a towel or, in Tom Gentry's case, slapping a yardstick in the dust to make the animal step livelier. Some say that these last-minute demonstrations are only for show, that knowledgeable buyers know what they want weeks before the sale. But this is not always the case. For example, the splendid bay colt in barn No. 6 was sent over from England for this sale and this is the first opportunity most American buyers have had to get a look at it. Its owner went to the expense and trouble of shipping this horse, the son of a champion, to Keeneland because he believes the colt will go for what it is worth here. "If your wife or girl friend drags you into a high-class shop, you're more likely to spend

Group of English, Scottish, Irish buyers wonder if this Keeneland colt would be a winner on British track.

a lot of money," he says, explaining that Keeneland buyers appreciate quality and are willing to pay for it. The horse's trainer, a robust, ruddy man in his mid-40s with a thick North-country brogue, never stands still while the horse is on display, but trots at its flank whispering words of encouragement. These men have traveled 5,000 miles to sell only one horse. The respect and confidence they have in the animal does not escape the passersby. The bidding on this horse may be high.

Owners and trainers are happy to show their horses to anyone with a million-dollar line of credit, but they are particularly eager to do so for a handful of buyers known for driving the price of the best horseflesh into the stratosphere. Standing out among this cavalcade of standouts are the four brothers of the Maktum family. The Maktums are sons of Sheikh Rashid bin Said al-Maktum, ruler of the Gulf state of Dubai, 1,500 square miles of oil-rich desert tucked into a tiny corner of the United Arab Emirates. Dubai has a strict Islamic law that forbids betting on horses or anything else. But the law does not forbid the ownership of racehorses, and the Maktums have taken mighty advantage of this loophole. The royal family now has some 500 horses in training, mostly in Ireland, England and France. The mere presence of the "Boys from Dubai" and their entourage in front of a Keeneland stall generates excitement—a crowd gathers, newspaper photographers start snapping, the horse's owner begins to think about how he'll invest the $5 million or so the sheikhs will undoubtedly bid on the animal. Two years ago, a Maktum brother, Sheikh Mohammed, purchased 46 yearlings at Keeneland for $51,275,000. That was nearly 29 percent of the total sales receipts.

Robert Sangster, in quiet moment with friend before Keeneland bidding, is European rival to Arab buyers.

The Maktum family is one of the four or five groups of British, Arab and Greek investors that are, some say, slowly draining the best of America's thoroughbred blood. Blood is the key to the racing industry—it is the main determinant of a horse's worth before it is old enough to prove itself at the track. All true thoroughbreds are descended from three stallions —Arabian, Turkish and North African—and approximately 50 English mares whose names were recorded in the first *General Stud Book* at Newmarket, England, at the end of the 18th century. Since then, owners have mixed and remixed bloodlines in the relentless quest for a filly or colt with all the good points and none of the bad points of its ancestry. The Jockey Club, the organization that sets the rules that all thoroughbred owners must follow, forbids the artificial insemination of thoroughbred mares. So all breeding is done

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Nelson Bunker Hunt, silver magnate and horse farmer, makes notes on a yearling he might bid on.

in the traditional manner, with onlookers observing from a glass booth (or similar vantage point) to verify the event. A champion racehorse or the mother of one is actually worth more as the progenitor of future champions than it is at the track. To breed a mare to Northern Dancer, the small and not altogether dashing winner of the 1964 Kentucky Derby, for instance, can cost as much as a million dollars, with no guarantee of getting a foal.

Of course, Northern Dancer has sired 117 stakes winners in his 25 years at stud and is the most sought-after breeding stallion in the sport—he is not an easy horse to get to. A group of investors headed up by Robert Sangster, heir to a Liverpool-based soccer-betting operation and the most successful horse owner in Europe, has, along with the Maktum family, cornered the market on Northern Dancer's best offspring, and it is rumored that jointly they will soon control the bloodline. Both Sangster and the Maktums seem to have bottomless pockets and their bids at the yearling sales have put all but the most intrepid American investors out of the running. Between them they now own more than 200 of the fastest and best-bred racehorses in the world and, it is said, they will soon be breeding and selling their own stock rather than relying on American-breds. This has some traditionalists worried, but the majority of American owners and breeders take a philosophical attitude. After all, if it weren't for Arabian stallions and English mares, there would be no thoroughbreds to quibble about; and if it weren't for English and Arabian money, American yearlings might not be selling for the king's ransom they now command at Keeneland.

The breeding and racing of thoroughbreds has always been a favorite diversion of the moneyed class, but it was not until 1956 that it was considered a way of entering that class. That was the year that Leslie Combs II syndicated his first horse. Combs is the founder of Spendthrift Farm, a sprawling 2,142-acre breeding operation not far from downtown Lexington, with close to 400 horses and 150 employees. Combs sold 32 shares with breeding rights to champion stallion Nashua for $39,100 apiece, thereby grossing considerably more than a million dollars, four times what the horse had won on the track. It was a lovely idea, one that caught on like wildfire among the horse-raising set. Syndication makes it possible for owners to retire horses to stud after just a year or two of racing and still make an enormous profit. In fact, a horse of good pedigree that wins a couple of important races is rarely allowed to run past the age of four—it's worth much more to its owner in syndication than it is at the track. There are, of course, exceptions to this rule. John Henry, the biggest money-winner in the history of the sport, retired in 1984 at the age of ten with more than $6.5 million in total earnings. John Henry was allowed to run that long because he is a gelding—his retirement will be a peaceful one.

The profit potential of syndication is inviting enough to make horse owners out of investors who can't tell a bay mare from a chestnut colt. As one observer put it, "Horse racing has evolved from being the sport of kings to being a commodities market." Spendthrift Farm has gone so far as to offer shares of its operation on the American Stock Exchange and purists worry that other farms will follow suit. Few individuals can risk a million dollars or more on a horse that is more likely than not to be a loser. But they might be willing to pool their resources with others and invest

Sheikh Mohammed (right), one of Maktum brothers, spent more than $51 million at Keeneland in 1984.

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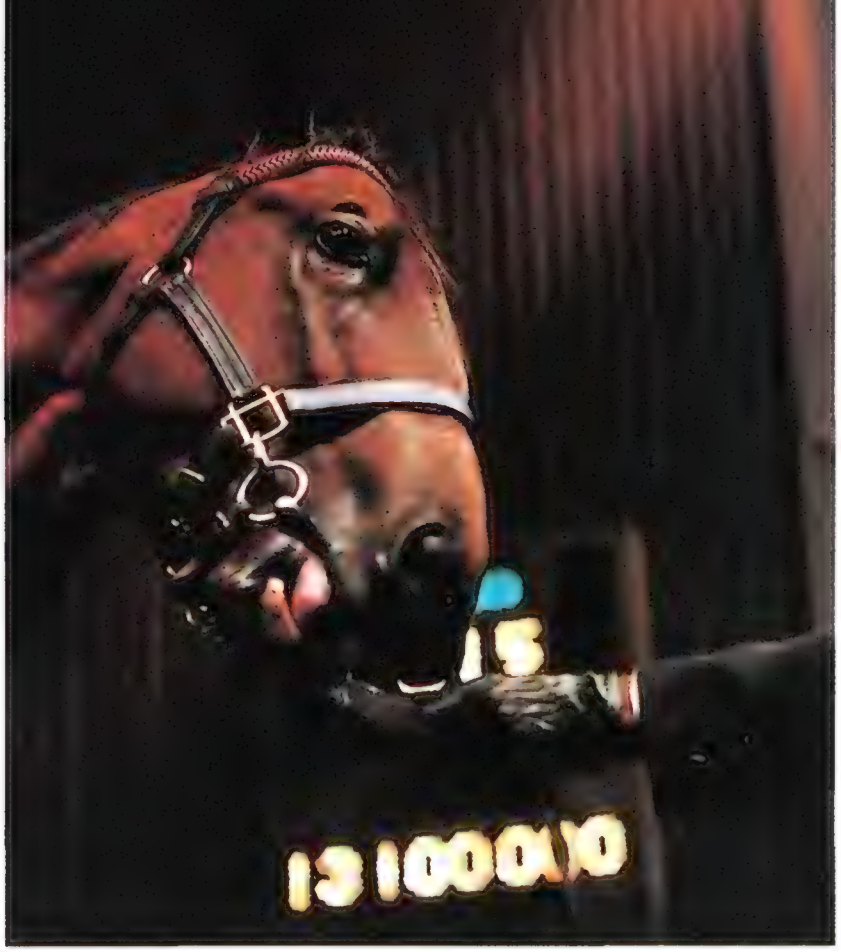
Kentucky's high-stakes horse auction



Record price, paid for Northern Dancer's grandson, flashes on the electronic board as gavel bangs down.

Bid spotter, watching from sidelines, gives sign that auctioneer's price has been met by someone in crowd.

in half a dozen or more horses. It's still no blue-chip investment—according to Wall Street analysts, fewer than 50 percent of the buyers profit from the deal—but it helps narrow the odds. Besides, money is only part of the equation. As one Beverly Hills investor who owns a share in 37 horses put it, "They don't take your picture in the winner's circle when you make a good real estate deal."

Nor does a piece of real estate develop the weak knees or bad enough cough that may render it valueless. Only three percent of all thoroughbreds ever win a race, and only about one out of ten even earns its keep, which, for the most promising runners, can cost as much as $25,000 a year, or about the annual income of the average American family of three. Snaafi Dancer, a colt by Northern Dancer that sold to the Maktums for a record-breaking $10.2 million at Keeneland in 1983, never ran because of weak knees, and is now at stud. Anyone who invests in the horse business, it is said, had better like horses as much as money.

Still, it is money, not a love of horses, that gets one taken seriously at Keeneland. No newcomer gets a reserved seat in the auction pavilion without a credit check—those with less than a half-million or so to spare may not qualify.

Finally the auction, which seems almost anticlimactic after the hoopla that precedes it, gets under way. One by one the horses are taken from their barns and walked to the back of the pavilion, where they are held in nervous anticipation until their number is called. A pair of sliding doors is opened and the equine equivalent of a young Arnold Schwarzenegger is led into the

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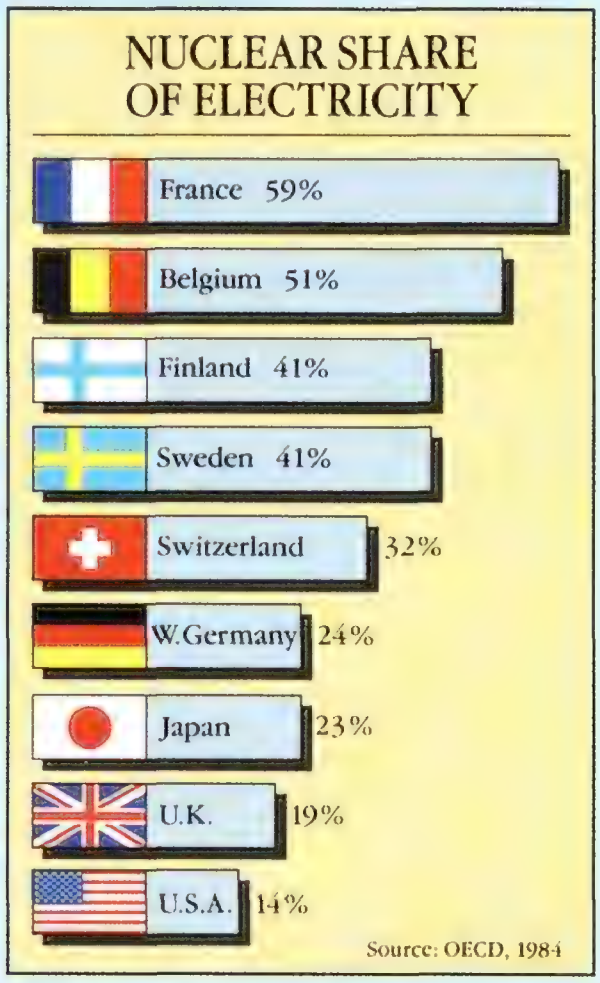

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which is about half the average time it now takes to build one in the U.S.

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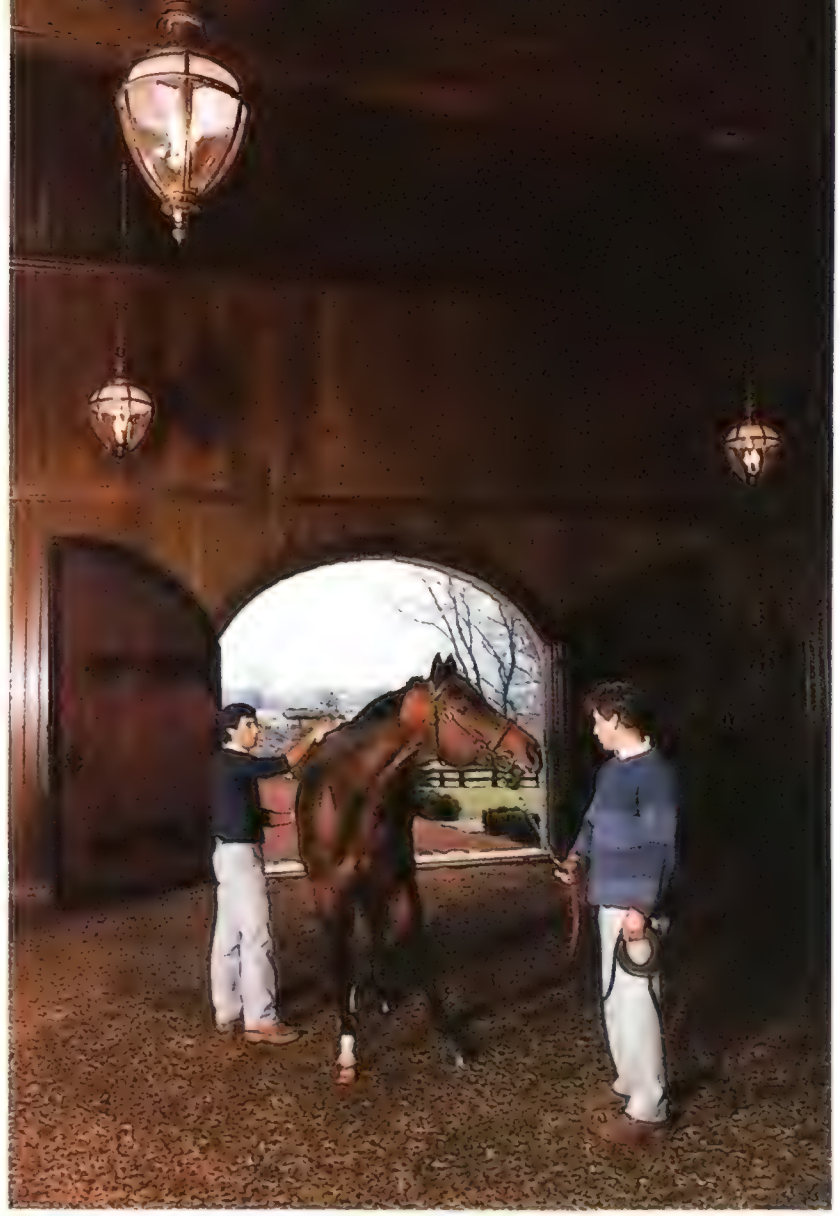
ring. Ringmaster Francis Wilson, one of two men in charge of holding the yearlings as the bids are fired, has worked with horses since graduating from high school 38 years ago, and it is said he can gentle a skittish colt better than just about any man alive. "I try to keep them moving and turning, I don't let them stand still too long," he explains. Wilson says he treats all the horses the same, whatever their worth, and tries not to grimace too obviously when they step on his feet. But although he's seen and worked with enough horses to tell the good buys from the bad, he won't invest in one. "My brother and I used to own a mare and two fillies," he says, "and we sold them for a good profit. But now I'm a deacon down at the church and it wouldn't be right for me to get involved in something that had to do with gambling."

Meanwhile, the auctioneer warms up the crowd with a recitation of the thoroughbred's assets: a quick synopsis of its pedigree, a rundown of various races won by its relatives, and maybe a warning as to the horse's particular habits. Cribbers, for example, tend to chew on the wood of their stalls, a habit that can lead to stomach problems but does not seem to diminish their worth. When all is ready, the auctioneer launches into the familiar incantation intended to provoke bidders into a frenzy of one-upmanship. Thomas Caldwell is the head auctioneer at Keeneland, brought in especially for the event from his home in Eagle Point, Oregon. A massive basso profundo with persuasive powers that any evangelical preacher would envy, Caldwell keeps in shape by swimming, walking and deep-breathing exercises. Working horse auctions, he says, is enormously taxing, especially when the stakes are as high as they are at Keeneland.

"If you think about it, the money will scare you to death," he says. "You have to think of it like Monopoly money . . . it's like when you're buying Boardwalk—you're not *really* buying Boardwalk." Caldwell says it's not always easy to force a bid higher when it's already so high that it frightens him. The trick, he says, is to know your buyers. "If I think a particular buyer wants a horse and is willing to go higher, I'll egg him on by saying something directly to him, like 'Looks just like your other big one' or 'It's a match for the one that won the race for you last week.' " It takes a real professional to pull off such personal appeals because just knowing who's bidding requires a very practiced eye. Most people try to keep their interest in a horse to themselves by disguising their bids as random gestures. A flick of a cigarette ash, a stroke of a beard, even a raised eyebrow can indicate a bid. These signs are so subtle that the auctioneer is assisted in his interpretation of them by a team of bid spotters, a half-dozen men decked out in suits who stand in the aisles and, quite literally, spot bids. Charles Richardson has been bid spotting at Keeneland since 1950, when there was no electronic board to help keep track of the numbers.

"People are very discreet about bidding," he says. "Sometimes they just take off their glasses, or stick a foot in the aisle, or open the catalog. They don't want other people to know that they're bidding because they



Kentucky home for $40 million stud, El Gran Señor, is a barn with teak doors and oak-paneled walls.

Leslie Combs II listens intently to auctioneer. He was first to syndicate a horse for more than $1 million.

DEWAR'S PROFILE:

THOMAS B. STEVENS

HOME: Lakewood, Colorado.

AGE: 39

PROFESSION: Harpsichord and clavichord builder.

HOBBY: Skiing. "I didn't move out here from New Hampshire for a change of climate."

LAST BOOK READ: *Drums Along The Mohawk*, Walter Edmonds.

LATEST ACCOMPLISHMENT: Completed his third instrument of 1985. "For somebody in my business, that's high-speed production."

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don't want to tip off the competition. Say they've had luck with a particular bloodline, they don't want other people to know about it and bid against them."

But sometimes discretion seems beside the point. Such was the case in this year's record-breaking duel for a magnificent bay colt that was grandson of Northern Dancer and half-brother of Triple Crown-winner Seattle Slew. (Yearlings aren't given names until they are sold.) Usually about half of the 703 reserved seats in the sales arena are empty, but when this colt stepped up to the auction block almost every seat was filled and the aisles and rear of the pavilion were crammed with onlookers. Television cameras rolled even before the bidding began—everyone knew this was a "big" horse. A million, then two million were bid in the flash of the gavel. The faint of heart quickly dropped out, muttering "too rich, too rich" and closing their catalogs. The determined stayed with it, bringing the price up to $9 million in less than two minutes. But by the time the $10.1 million mark was passed, all but two parties were out of the bidding: an American syndicate represented by horse trainer D. Wayne Lukas, and a mostly European group headed by Robert Sangster. Lukas made no secret of his interest and consulted openly with his partners when auctioneer Caldwell suggested he bid $13 million and "end all this." Lukas obliged, but to no avail. Sangster bid $13.1 million without hesitation and the contest was over. The crowd roared, the photographers snapped madly and a pack of journalists dashed to the back of the arena where Sangster makes his bids. Lukas slumped in his seat. For the ninth year in a row, the top-priced yearling at Keeneland had been sold to race in Europe.

Europeans have flocked to Keeneland since the early 1970s, when the dollar's decline made such purchases feasible and when it became startlingly clear how well American-bred horses could perform on French, English and Irish tracks. The Europeans brought a certain panache and style to the event, as well as enough money to help Keeneland surpass Saratoga as the country's premier yearling sale. Saratoga Springs has a beautiful track (SMITHSONIAN, August 1981) and a long tradition of catering to the demands of the ultrarich. Keeneland's founders hoped to create a "Saratoga of the South" when they opened the new racetrack in 1936. At the time, it seemed rather unlikely.

Keeneland was carved from 147 acres of farmland purchased from J. O. Keene, a horse breeder and trainer who had actually laid out his own private racetrack and a clubhouse on the property, planning to make it public. After spending nearly 20 years and about $400,000 on the project, Keene was forced to give it up when his finances gave out during the Depression. But the Keeneland Association, which bought the property for $130,000 in cash and $10,000 in preferred stock, allowed him to live and train his horses at Keeneland without charge until his death in 1943.

Not surprisingly in an area with a thoroughbred-racing tradition stretching back to 1787, Keeneland

Thoroughbreds race on the 1.1-mile Keeneland track, in 50th year. Yearlings race only after they are sold.

Race Course was an immediate success. But Kentucky horse breeders continued to ship their best horses north to Saratoga for the yearling sales because they believed that, as one put it, "We had to go where the money was." World War II put a sudden end to that when gasoline rationing made the shipment of horses impossible. In 1943, Keeneland held its first select yearling sales in a tent on the racecourse grounds. Two years later a horse bought at that sale, Hoop Jr., won the Kentucky Derby. Kentucky breeders decided that maybe staying close to home wasn't such a bad idea.

Today, yearlings sold at Keeneland's July sale command, on average, more than double the price of those sold at Saratoga. This seems fitting. After all, Saratoga has famous medicinal springs, charming art galleries, and the New York City Ballet and the Philadelphia Orchestra in the summer. But Man o' War is buried just six miles north of Lexington.

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By Roger Warner

Ticks and deer team up to cause trouble for Man

It's called Lyme disease—
deer carry it, ticks disperse
it and people are getting it

"Brochures and public meetings can help teach people to inspect their bodies carefully every day for ticks or signs of a rash."

On the morning of July 4, 1984, a semiretired scientist named William Shurcliff cut the meadow grass in back of his summer home for a celebration later that day. For several decades, his family had given a kite-flying party on Independence Day in the coastal town of Ipswich, Massachusetts, 30 miles northeast of Boston. The party, mainly for children, had become a tradition in the community and the 1984 version was a success. A couple of weeks later, however, in his office at Harvard University, where he writes books on solar energy and housing insulation, Shurcliff began to feel strange sensations. First he became so cold that he began to shiver. Then he felt "awful" all over, as if he were coming down with the flu. Then he started to feel so hot that he began to sweat. He went home and there he became so drowsy that he could hardly keep his eyes open.

Shurcliff discovered that he had an illness which has become commonplace in Ipswich in recent years. It was Lyme disease, a bacterial infection named for the town in Connecticut where it was first recognized a little more than a decade ago. It had been transmitted to him by the bite of an infected deer tick. The proof was a skin rash near his elbow, where a tick had probably attached itself when he cut the field in back of his house.

After a few days of taking antibiotic pills, Shurcliff was pleased to see the rash disappear and he felt fine. That August, however, tiny intermittent pains began to flash through his muscles. In September, his heart was found to be beating irregularly. That fall and winter his ailments became more severe. Sometimes, for no apparent reason, his heart would start hammering in his chest, as if he had just climbed steep stairs. He had chronic intestinal gas. He lost weight. He tried different remedies, including dietary changes, rest and more antibiotic pills, but nothing worked. Though blood tests were ambiguous, his cardiac irregularities fit the pat-

Illustrations by Jim Aplin

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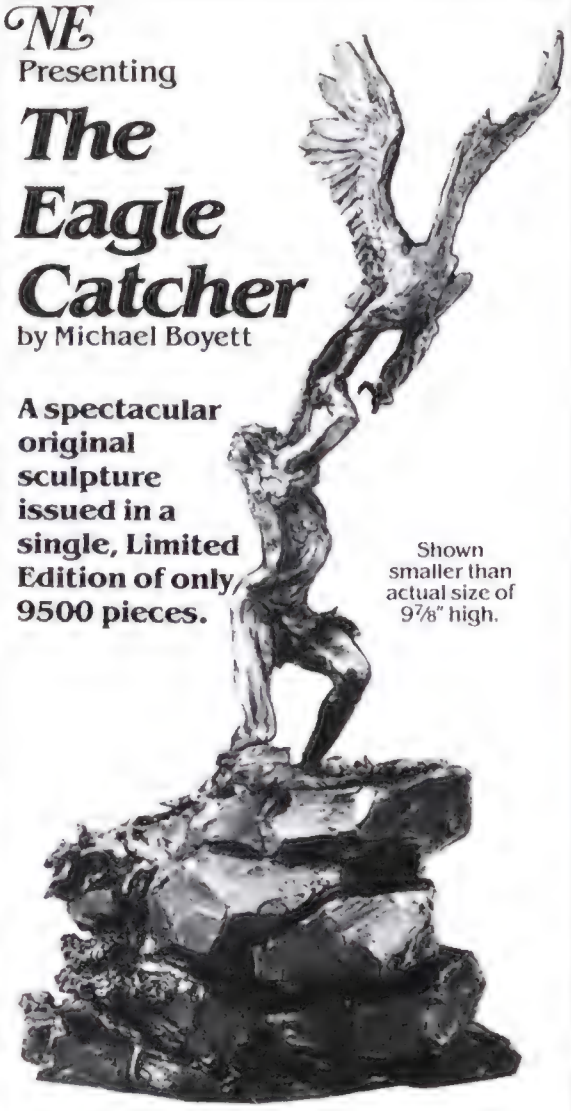

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"In theory, if all the deer in a given area were removed, most ticks would die. But the idea is anathema to animal-rights activists."

tern of one of Lyme's known long-term effects. He entered a hospital. For ten days he received penicillin directly into his veins.

Today Bill Shurcliff has recovered, but he stays away from his Ipswich country house in the May-through-July peak of the tick season. He goes there only rarely the rest of the year and he has canceled the traditional kite-flying party.

In many parts of the country, the simple act of venturing outside involves a certain amount of risk these days, and Lyme disease is not the only reason why. In the Upper Midwest and Florida, mosquitoes are transmitting viruses that cause encephalitis, a potentially serious inflammation of the brain (SMITHSONIAN, June 1983). In the Rocky Mountains and elsewhere, ticks are still carrying the disease known as Rocky Mountain spotted fever. Even in unspoiled mountain wildernesses, drinking stream water can give hikers *Giardia*, a microscopic intestinal parasite. We Americans like to think that we're immune to nasty little organisms in the great out-of-doors, but whenever some "new" illness like Lyme disease comes along, we are reminded once again of how vulnerable we really are.

Lyme disease is a curious phenomenon. It has been called a "suburban disease," since—at least in the Northeast—it usually occurs where houses are near woods or other areas in which deer have been allowed to proliferate. So far it has showed up in 24 states, though about 90 percent of the cases occur in just seven: New Jersey, New York, Connecticut, Rhode Island, Massachusetts, Wisconsin and Minnesota. Clusters of cases have occurred as far south as Georgia and

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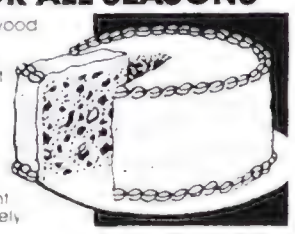

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Texas and as far west as California and Oregon. In the opinion of certain medical observers, the disease is clearly spreading. The federal government's Centers for Disease Control (CDC) in Atlanta list 1,498 confirmed cases nationwide in 1984 versus only 599 in 1983 and 226 in 1980. According to CDC researchers, these are just a fraction of the real total, since doctors in most states are not required to report the cases they find.

Though the infectious agent itself is known—a corkscrew-shaped microorganism classified as a spirochete—the effects of the disease on humans are variable and rather baffling. Some people who have been bitten by infected deer ticks, for example, do not seem to get the disease. Their bodies' natural immune systems overcome the microbes invading their bloodstreams—sometimes temporarily, sometimes permanently. Most, however, develop the reddish skin rash along with other first-stage symptoms, including headaches, fever, chills, drowsiness, aches and a flulike or meningitislike condition.

Treated promptly with antibiotics, the majority of these people recover quickly. If they are not treated—and for a small percentage of people like Bill Shurcliff, even if they *are* treated—some develop second-stage effects such as meningitis, paralysis or cardiac irregularities; or third-stage effects, usually arthritis but occasionally chronic skin disease or neurological disorders. To top it off, constant fatigue and lethargy make it impossible for some people to carry on.

Lyme disease is hardly ever fatal and until recently, in fact, it was not known to be fatal at all. If it seldom kills, if it is treatable and if it has no long-term effects on most of the people who get it, then how concerned should we be? My own answer to this question is biased. My family comes from Ipswich and though I have never lived there year-round, I spent summers there as a child and continue to visit there as often as I can.

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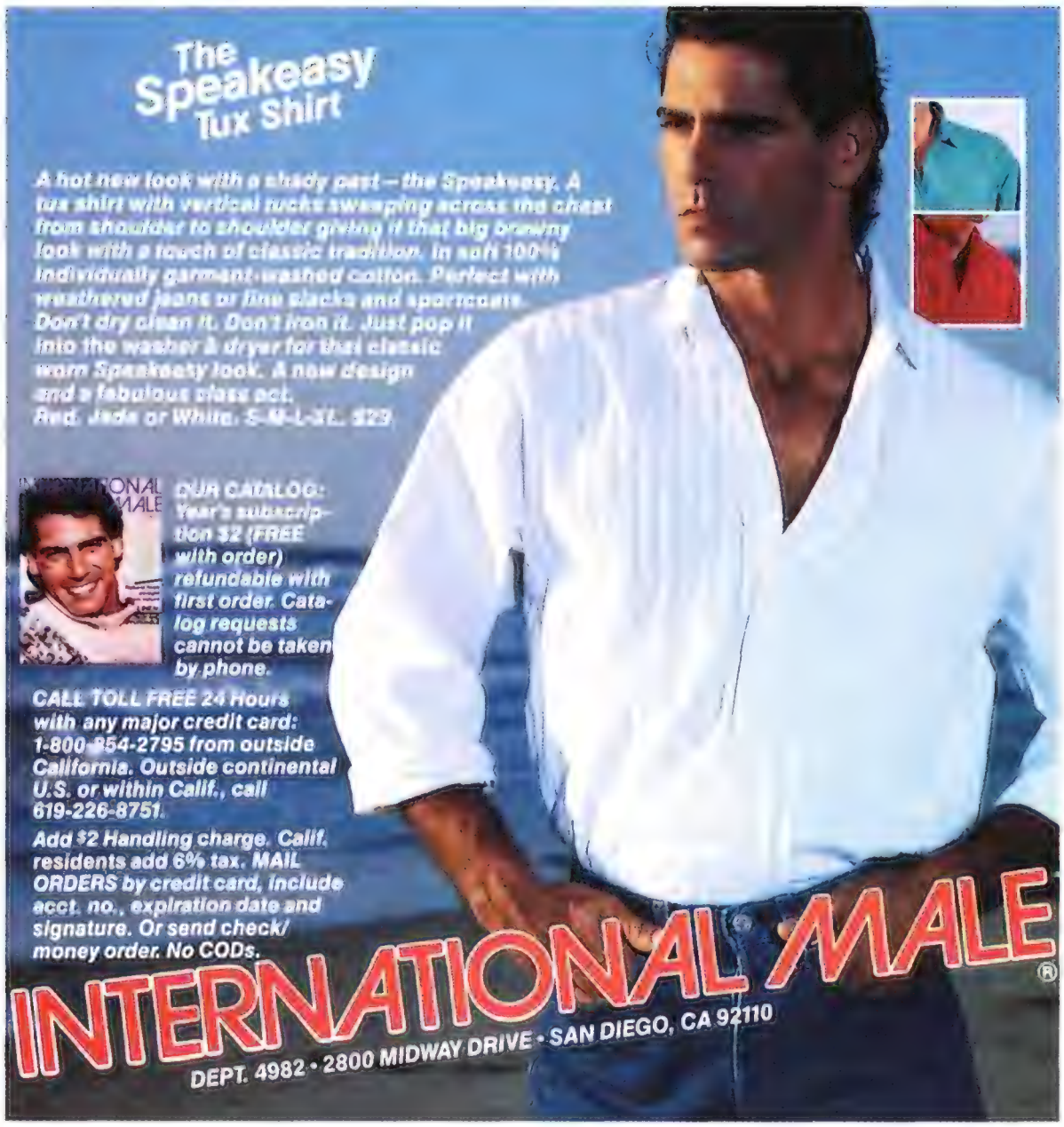
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Bill Shurcliff is a highly regarded Ipswich neighbor. A white-tailed deer, carrying ticks infected with the disease, could run from his place to mine, or from my place to his, in less than a minute. The house of another neighbor who has been hospitalized for Lyme disease is even nearer. Of the residents of this rural road, 25 percent have had Lyme disease at some point in recent years. A spot nearby is said by a professor at the Harvard School of Public Health to have the highest concentration of deer ticks in the world.

I stand a good chance of getting Lyme disease myself. For the past few years I have been clearing my patch of woods in Ipswich of brush. During that time, I suppose I have picked a dozen of the tiny deer ticks, *Ixodes dammini*, off my skin. The adult females are about half the size of the ticks commonly found on dogs and have a fringe of scarlet around their hind parts. The adult males are all black and smaller. The immature ticks, the nymphs and larvae, are not much larger than the period at the end of this sentence. They are the primary transmitters of the disease.

Prevention of Lyme disease is simple: if ticks don't bite me, I won't get the disease. After working in the woods I inspect my skin, every square inch of it. I have been told that even if an infected tick bit me, and about half of them are infected, I would have only a few hours to remove it before the disease entered my bloodstream. This threat doesn't keep me from doing what I want to do. Still, my mind is never entirely at ease in the spring and summer.

I often see white-tailed deer when I walk into the woods. They abound now in this part of Massachusetts, where the mixture of openings and woods with dense underbrush provides a perfect habitat. Earlier in this century, when my father and Bill Shurcliff were young, deer were rare and my woods was a field that was used as a place to stack salt-marsh

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hay. When the hay harvesters stopped using the field, early succession plants such as cedars, sumac and a shrub honeysuckle sprang up, followed by oaks and hickories. Much of the nearby farmland also grew up to a mixture of brush and woods.

Hunting was forbidden on a 2,100-acre block of land nearby, the Crane Memorial Reservation and the Crane Wildlife Refuge (SMITHSONIAN, June 1977), and this gave the local deer herd a haven in which to multiply. By the 1970s, when I began to go back to Ipswich, deer had become commonplace. I felt protective of them and most of my neighbors did, too. We didn't allow hunting on our land. I now believe that was a mistake.

By the early 1980s, the deer population of Ipswich was greater than the land could support. On the Crane properties, which include a beach with a forested interior and several large islands in the marsh, deer began to die from starvation in the winters. At the same time, tiny deer ticks, which nobody could recall seeing before, began to proliferate, many of them carrying the Lyme disease spirochete. In 1985, with nearly 250 deer occupying land that could support

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perhaps 50, a limited public hunt was held on the Crane properties.

By that time, nearby private-property owners had already reversed their earlier stands and given selected hunters permission to shoot. In my woods alone in the first year of hunting, three bucks were killed. On my recent trips to my Ipswich woods I have usually seen only one doe. I do not look at her with any affection. If she fits the normal profile, she carries the Lyme disease microorganism in her bloodstream. In the fall, she might have dozens or even hundreds of adult ticks fastened to her, swollen to the size of raisins.

About 150 miles to the southwest of Ipswich, in Lyme, Connecticut, the fields around Polly Murray's house had also grown up to brush and trees by the 1970s. White-tailed deer had made a comeback there, too, and Mrs. Murray enjoyed watching them from her windows. What she did not enjoy were the unexplained illnesses that her family began to suffer more than a dozen years ago. She was hospitalized for skin problems, fever, and arthritic problems in her neck, jaw and various joints. For a time, one of her sons became paralyzed in his facial muscles and developed joint swelling. The doctors said that he had juvenile rheumatoid arthritis.

Mrs. Murray, who had a solid lay knowledge of science from her college days, went to the library to read the technical literature. She came away confused. If, as the books said, juvenile rheumatoid arthritis were both rare and noninfectious, what was happening to her family? For eight years she kept careful records and eventually found that more than 30 of her neighbors seemed to have the same problems. Mrs. Murray repeatedly telephoned state medical authorities to report her findings and request an investigation. At the same time, another woman from the same area, Judith Mensch, was reporting similar observations to the same authorities.

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At first, doctors wouldn't take the two mothers seriously. Confined within their narrow specialties, the rheumatologists didn't want to hear about skin rashes, and the dermatologists weren't interested in swollen joints. Finally, Mrs. Murray came into contact with sympathetic researchers, including Dr. Allen C. Steere, a rheumatologist who studied at the CDC and teaches at the Yale Medical School. He looked at the notebook she kept of her neighbors' ailments, contacted local physicians and invited affected residents to Yale for evaluation. Some of those neighbors remembered getting a reddish, bullseye-type skin rash before feeling ill. The rash, Dr. Steere learned, was similar to something that had been described in Europe as early as 1909, a lesion called *erythema chronicum migrans*, which results from tick bites. Some of the patients from Lyme saved the ticks that had bitten them and it wasn't long before Dr. Steere made a definite connection between the deer ticks and the disease. His pioneering articles in the medical literature prompted immunologists, epidemiologists, wildlife ecologists and other "ologists" to take a serious look into Lyme disease.

During that same period, still other researchers were investigating another new tick-transmitted disease called babesiosis. An infection of red blood cells resembling malaria, babesiosis is found in a much smaller area than Lyme disease—mainly Cape Cod and the islands of Nantucket and Martha's Vineyard in Massachusetts, plus the outer parts of Long Island in New York. Dr. Andrew Spielman, a medical entomologist with the Harvard School of Public Health, identified the tick species that spreads both diseases in the Northeast, *Ixodes dammini*. (He named it for a retired colleague, Dr. Gustave Dammin, who later caught Lyme disease.)

In 1981 Swiss-born Dr. Willy Burgdorfer was looking through a microscope for organisms that cause Rocky Mountain spotted fever when he noticed some odd, filamentlike, spiral-shaped bacteria that he identified as spirochetes. The sample under his microscope was from a part of Long Island where Lyme disease had appeared. Burgdorfer, a medical research entomologist in Montana and an expert on both spirochetes and tick-carried diseases, realized that he had found the Lyme disease agent. The spirochete was named for him: *Borrelia burgdorfer*.

Other researchers found that dogs, like humans, can suffer from Lyme disease; that migrating birds have carried ticks infected with Lyme disease to the Southern states; and that other tick species besides *I. dammini* can transmit Lyme disease. Alarming cases began to show up, such as a New York City surgeon who was paralyzed in both arms by Lyme disease. After several years of therapy he has recovered 90 percent of the use of his arms, but he has had to change specialties within the medical profession. Pregnant women have been found to pass the Lyme disease spirochete to their unborn babies; a few of those fetuses have died or become deformed, and researchers are trying to determine whether the spirochete was actually the cause of the problem.

Lyme disease is now known to exist in at least 19 countries, including France, Sweden, Italy, the USSR and Australia. The earliest reported case in the United States seems to have occurred in 1962 on Cape Cod. Did the disease spread fairly recently to this country from someplace else, such as Europe? Nobody knows.

For all the uncertainty, researchers have managed to find out how people get the disease. The answer, at least for the Northeastern and Midwestern United States, lies in the interaction of several different creatures. The first of these, the spirochetes, which have neither head nor tail but simply rotate their microscopic corkscrew-shaped forms to propel themselves, find mammalian bloodstreams a fa-

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vorable environment for living and multiplying. But the spirochetes are not able to get into bloodstreams on their own. They have to be injected there by the deer ticks, which are thousands of times larger than the spirochetes.

The ticks grow through several stages, from larvae to nymphs to adults, before they are able to reproduce. At each stage, they need one blood meal, for a total of three meals during their two-year lives. The larvae tend to feed on white-footed mice. The nymphs feed primarily on mice, birds or humans. The adult ticks usually feed on white-tailed deer, though any other warm-blooded animal, including people, will do. If the host animals already have the infection in their blood, the nymphs and ticks relay it to their next blood source. Mice, deer and other creatures seem to be unaffected by the spirochetes. Why people suffer from them is still unknown, although the human immunological system certainly plays a major role.

For one other important question—how can we stop the disease?—scientists have no sure answers. It is unlikely that they will find a vaccine any time soon to keep humans from getting the disease in the first place. Most researchers believe that it is impractical to try to stop Lyme disease by wiping out the ticks and the field mice that act as infection carriers. Deer are probably the weak link in the chain. In theory, if all the deer in a given area were removed, a few adult ticks would find other mammals to feed on, but most ticks would eventually die without reproducing. The number of cases of Lyme disease would then dwindle. In practice, however, scientists and wildlife managers are cautious about recommending the removal of deer, both because they lack the data to back up their theories and because "removing" deer essentially means shooting them. The idea of shooting deer—especially in suburban areas—is anathema to

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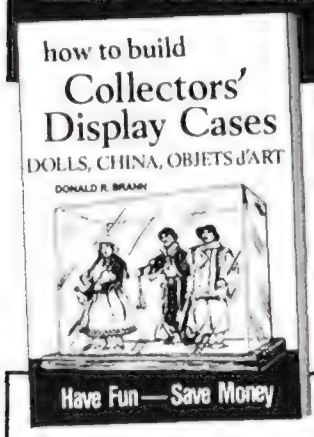

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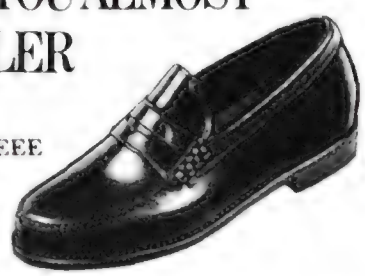

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animal-rights activists and they tend to respond with lawsuits and other forms of protest. I can understand their feelings. After all, I used to like deer myself.

For the time being, prevention is the best way to help reduce the disease. Posted warning signs can discourage people from venturing into brush or woods in tick-infested areas, particularly in the May-through-July peak of the Lyme disease season. Brochures and public meetings can help teach people in tick-infested areas to inspect their bodies carefully every day and to see a doctor at the first signs of the characteristic skin rash or other symptoms. But the prevention approach has its drawbacks. Warning people about ticks in areas where the disease rate is low is like crying "Wolf!": after a while, people stop paying attention. Moreover, many people, especially children and the elderly, have trouble finding the nymphal ticks even if they look. And in perhaps 25 percent of the Lyme disease cases, the skin rash fails to appear, meaning that these victims might not realize until later that they are infected—if they ever realize it at all.

In Ipswich, where the danger is better recognized than in most places, a combination of deer hunting and public education seems to have stabilized the situation. In 1985, there were nine confirmed cases of Lyme disease on the road where Bill Shurcliff and my family have houses, roughly the same as in previous years. Without the preventive countermeasures already mentioned, the number would undoubtedly be higher. The bad news is that even this "progress" comes at a cost—the cost of canceling outdoor activities like yard work, hiking and kite-flying parties. Furthermore, the recent research findings underscore the extreme seriousness of the later stages of Lyme disease. Last fall, Dr. Steere and other doctors reported a death from Lyme disease—the sudden heart failure from pancarditis, or spirochete involvement throughout the heart muscle, of a man from Nantucket. This is only the first known death of its type. It is not a cause for hysteria, but it is definitely a reason for concern.

"Lyme disease usually occurs where houses are near woods or other areas in which deer have been allowed to proliferate."

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Book reviews

Cities & People: A Social and Architectural History
Mark Girouard
Yale University Press, $29.95

In the first pages of *Cities & People*, British architectural historian Mark Girouard sketches in vivid, spare strokes the wonders of Constantinople in the ninth and tenth centuries: with Rome now a mere scattering of small, gutted settlements, Constantinople still sheltered some 800,000 people within its 12-mile-long walls. Its colonnaded streets were resplendent with bazaars carrying silks, spices, gems and junk from Russia, India, Byzantium, Media. Among its several hundred churches and chapels was Hagia Sophia, whose 1,000 lamps transformed it each night into a glowing beacon for ships approaching the city's thriving harbor. The "richest and most sophisticated city in the world," was still powerful and inviolate—and fantastic. "Constantinople floated like a vision above the waters of the Bosphorus. . . . Visitors from the West brought home wonderful stories, in which truth and fantasy were curiously mixed, for a big city was completely outside their experience."

In part because Girouard starts his latest book with such verve and inventiveness, there is sometimes a wish for more—sometimes for less—in reading its remaining fact-filled, stunningly illustrated pages. The problem is scope. While the subjects of Girouard's earlier volumes were self-limiting (among his credits are the popular *Life in the English Country House* and *The Victorian Country House*), *Cities & People* casts its net too far and wide to often snare as fresh or crisp a catch as in its first pages. Girouard meanders through the vast, often familiar tapestry of Western European history from the ninth century to the present, stopping on the way to give special attention to ascendant cities.

From the 13th to the 15th centuries it was Bruges, the "essentially practical town" whose reason for being was to make and sell cloth; and Venice, the rich, peaceable city, which "never having had to adapt to the motor car," even today retains a medieval street system. In the 15th and 16th centuries it was Rome, successor to a once vast empire and capital of Christendom. Before becoming "gloriously bankrupt," as Girouard nicely puts it, Rome was physically revived at the behest of the popes, recently returned from Avignon. Nicholas V is said to have urged on his deathbed in 1455, "There must be something which appeals to the eye. A popular faith sustained only on doctrines will never be anything but feeble and vacillating."

With the decline of Rome and Southern Europe generally, Girouard veers north, following and surveying the path of power, and stops to focus on the continent's two most dynamic and influential 17th-century cities: Amsterdam, "a city entirely dedicated to making money," and Paris, equally devoted to gossip, intrigue and fantasy. Then, after giving highlights of 18th-century history, he fastens on 19th-century Paris, industrial Manchester, London and the development of suburbs, and finally 20th-century cities.

Cities & People thus serves as an interpretive reference for the history of Western urban life, with flashes of insight and originality and a number of provocative themes. One is the resemblance between medieval and modern cities. As Girouard writes, "To find a city as teeming, raw and rough as Manchester was in the 1830s one has to go back to Florence or Ghent in the 1330s. The Manchester cotton lords were as thrusting, ambitious, powerful and successful as the Italian or Flemish merchants and entrepreneurs who dominated the medieval textile towns." And, as he says in his epilogue, "even the modern model is not all that modern. Almost all the elements which have become so common in post-war cities existed before 1939, and some before 1900. . . ." Although he doesn't make the connection, one can identify readily from his descriptions a model for such new inner-city redevelopment efforts as Boston's Quincy Market, Baltimore's Inner Harbor, New York's South Street Seaport, among others. It is, of all things, 19th-century Paris, as redesigned by Baron Haussman with its broad boulevards intended for spectacle and festivity, its restaurants, cafés, great markets, bandstands, fountains. "The whole of Third Empire Paris," Girouard writes, "was in fact designed for enjoyable motion."

What of the future? Girouard singles out two dominant emerging urban types, the one a high-density downtown girdled by freeways, greenery and open space: Toronto, Chicago, Houston, Calgary. The other model is Los Angeles, a low-density, multicenter city, wasteful of space, dependent on the automobile and therefore especially difficult for the young, old and poor. There is also the nonurban alternative to continuous suburbia, which, defying the need for face-to-face contacts in government, education and business must remain peripheral and provincial. Besides, Girouard loves the roar and throb and excitement of big cities, which is why he undertook this enormous, ultimately rewarding work.

Andrea Oppenheimer Dean
Executive editor, *Architecture: The AIA Journal*

Good to Eat: Riddles of Food and Culture
Marvin Harris
Simon and Schuster, $17.95

If, like myself, you are a fact freak, try a few of these on for size:

- The Jains of India maintain insect shelters. The insects are provided with grain and sealed in a room that is opened only after ten or 15 years when the insects have died naturally.
- Eighty percent of the grain grown on U.S. farms is fed to animals.
- Hindus believe that each cow contains 330 million gods and goddesses.
- Beneath a cliff at Soultré-Pouilly in Burgundy is a pile of fossilized bones three feet deep covering 2.5 acres where Paleolithic hunters forced off herds of wild horses for food.
- The term "all-beef hamburger" is redundant. U.S. law says it must be all beef to be called a hamburger.
- About four percent of Americans have trichinella worms—the villains of pork-borne trichinosis—in their muscles, causing occasional mild, flulike symptoms.

These nuggets and others are marshaled by anthropologist Marvin Harris in his fascinating book, *Good to Eat: Riddles of Food and Culture*. Harris roams the globe to investigate problems that have spurred disputes among anthropological observers, including Hindu protection of cows, pig taboos (such as those of Muslims and Jews), the American cult of beef, the wide

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genetic intolerance for milk, and the human penchant for eating horseflesh, insects, pets and other people. Though it can get a bit gruesome at times, it is a very readable book—wry, provocative, almost jargon-free and full of the kind of bizarre information that can make you the star of cocktail parties for years to come.

In his discussion of Hinduism, for instance, Harris disputes the popular notion that the protection of cows is a retrograde theological quirk. He points out that among the Vedas, the Hindu cattle-and-farming people who dominated northern India from 1800 B.C. to 800 B.C., Brahman caste members were slaughterers of cows rather than their protectors, and argues that the cow-eating taboo arose when population pressures grew and Hindu society moved from a semipastoral to a farming way of life. Cattle became essential for their ability to plow, for manure and for milk. To this day, Harris maintains, the small Indian farmer would likely starve without his family cow.

Harris says the pig taboo among Jews and Muslims arose for the opposite reason—not to protect the pig, but to ban it because it required grain to thrive. In hot, semiarid climates, it was more efficient to let people have the grain and concentrate on raising cattle, sheep and goats, which can live on grass and stubble.

While these explanations seem to radiate sweet reason, it should be noted that their author is one of the most controversial anthropologists alive. For many years a professor at Columbia University, Harris pitted himself against the mainstream of anthropological thought from Franz Boas and Ruth Benedict down to Claude Lévi-Strauss by questioning the idea that the world is composed of unique and separate cultures. His goal is to make anthropology into a precise science, arguing that it should confine itself to the verifiable, which for him means demographic, technological, economic or environmental explanations. Harris, in his witty way, has referred to this approach as "demo-techno-eco-enviro." You get a hint of his method in the above discussion of taboos.

Harris is, in short, a materialist (one of his chief works is called *Cultural Materialism*) and he rejects religion, ethics, idealism, altruism, imagination or free will as explanations for any anthropological fact. The narrowness of his explanatory categories is both the strength and the limitation of *Good to Eat*. He assumes that all the problems he deals with have a rational basis and can be solved through his method, and he is ingenious—even brilliant—at teasing out explanations. But so many categories of possible explanation are eliminated by his assumptions that the book has a pat, indeed, a wizened air.

One attraction of the current widespread interest in ethnic cuisines is to touch the mystery of another culture. But there is no mystery at all, says Harris, the class smarty. His book offers amusing morsels, but ultimately what he serves up is a mere meal of demo-techno-eco-enviro.

Charles Monaghan
Writer on food, restaurants and book publishing

The Remarkable Expedition:
The Story of Stanley's Rescue of Emin Pasha from Equatorial Africa
Olivia Manning
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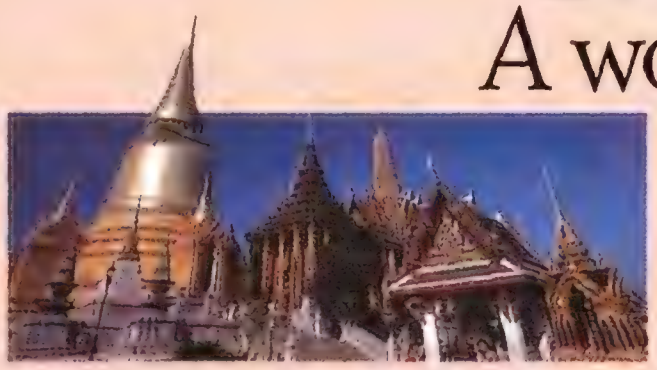

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and Livingstone—the 19th-century foreign correspondent ransacking the jungle for the intrepid missionary—but who in the world was Emin Pasha?

An intriguing question. The pasha was, in fact, an eccentric German doctor named Eduard Schnitzer, who passed himself off as a Turkish Muslim. A man of exceptional abilities, Schnitzer was a botanist, an ornithologist and a linguist, and in 1878 he was the Governor of Equatoria on the upper reaches of the White Nile. And an extraordinary administrator he was. He organized a postal service, introduced the cultivation of new crops and brought a sense of order and prosperity to Equatoria, an isolated Egyptian possession about the size of Ireland, hedged in by unfriendly savages, where today's borders of Sudan, Uganda and Zaire converge.

But by the 1880s, Sudan was ablaze with the Mahdi rebellion. Warfare and slave raids were laying waste to central Africa. European officials were killed or captured, even enslaved. Word reached Europe that only the mysterious Emin Pasha was keeping the beacon of civilization alight in the wilds. The British, of course, mounted a rescue expedition and enlisted a hero to lead it. Henry Morton Stanley, the Welsh-American explorer of the Congo, was the obvious choice.

Not so obvious is that the late Olivia Manning should have been the author of *The Remarkable Expedition*. (The book was first published in 1947—*The Reluctant Rescue* in the United States. The present volume is a reissue.) Miss Manning is known for half a dozen distinguished novels—indeed, Anthony Burgess has called her the "most considerable" of Britain's women novelists. But she rarely wrote nonfiction, and the book contains some confusing passages and wrong dates. Still, her narrative skill makes it compelling reading.

Stanley headed up the Congo River in early 1887 with a cargo of stores from Fortnum and Mason, a Maxim machine gun, nine junior officers and 623 porters from Zanzibar, their wages paid in brass rods and cowrie shells. The trip became a nightmare. The caravan was beset by disease, desertions, natives with poisoned arrows, and ants so ferocious they scared off the snakes. After less than two months in the forest, only 18 of 389 men in the advance column were fit for a day's march. They were reduced to feeding themselves by driving off the natives with rifle fire and stealing food from the villages. When the expedition finally reached Emin at Lake Albert, Stanley and his haggard stragglers seemed far more in need of relief than the pasha. Emin, in a crisply ironed white suit, arrived aboard a steamer loaded with livestock and grain, accompanied by a military band.

Furthermore, Stanley was baffled to learn, the pasha had no wish to be rescued. Even before the expedition had left England, Emin had been declaring: "Evacuate our territory? Certainly not. . . . Shall I now give up the work because a way may soon open to the coast? Never!" What the governor wanted was not retreat but military and political backing to maintain his position in central Africa.

While Emin procrastinated, Stanley trekked back 700 miles through the jungle to collect his rear guard, only to find it in ruins. And when he returned to Emin's territory, the governor had been overthrown by his own officers. Yet Stanley maintained that "I could save a dozen Pashas if they were willing to be saved," and eventually the caravan set out for Zanzibar, with the disconsolate Emin a virtual prisoner. Of

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Stanley's 623 Zanzibaris, only 255 got back home. They had been traveling for more than two and a half years.

Emin stayed on the African coast, refusing any further dealings with the British. Still, Stanley insisted the rescue had not been in vain: it had led to the discovery of the Mountains of the Moon and induced the rival European nations to agree on their spheres of influence in Africa, he said. Emin headed back into the interior in order to secure territory for Germany and was murdered at the behest of slavers in the Congo.

As popular history, *The Remarkable Expedition* comes nowhere near matching *The White Nile*, Alan Moorehead's collage of African exploration published in 1960. But Olivia Manning, who died several years ago, loved a good yarn, her husband tells us in a preface, and her saga of Emin Pasha is a fine one.

David Lancashire
Globe and Mail, Toronto

Sexual Selection and Animal Genitalia
William G. Eberhard
Harvard University Press, $25

Bill Eberhard has written an unusual book. Once biologists had a wide variety of interests, ranged over many fields of study and produced broadly applicable syntheses. But nowadays this kind of intellectual range is rare. Cell biologists usually stay inside the cell of their important field and organismic biologists rarely enter the cell.

Eberhard is an untypical polymath; his first love is the study of spiders. In this field he has made major and exciting discoveries. But he has also written innovatively about the evolution of microscopic structures within the cell and explored the function of horns in rhinoceros beetles. All this should have prepared us for this masterly book on the shape and structure of male and female genitals.

The shape of sex organs? At first blush this sounds like the stuff of pornography, but this is not a Kāma-sūtra, a text on erotica, of the animal kingdom. Essentially, the basic message is simple: male sex organs vary in shape and structure in complex ways over a major span of the animal kingdom; female organs do not. This fact is interesting and begs for explanation.

The first question to ask is whether this observation is true. Eberhard buttresses his premise with innumerable examples and beautifully clear illustrations. The difference is reflected in the fact that the structure of male sex organs is used in classifying

animals from flatworms, through insects (in their millions) to the vertebrates; female organs are not. The evidence appears to be overwhelming, but two considerations could mean that it is not. Taxonomists are predominantly male. There could be male bias in their findings. (Such a bias is not impossible in the "objective" realms of science. It seems to have occurred in some studies of primate behavior.) A possibly more serious source of error lies in the fact that in many groups male genitalia are external or become externalized in death, whereas female genitalia are much less conspicuous in the dead specimens that taxonomists work with. But this is probably a minimal source of error.

What then explains this evolutionary sexism? Why does it matter that male sex organs have diversified into myriad shapes and are embellished with warts, bosses, thorns, spines and hooks, while those of females are generally simple and relatively uniform? Past explanations were essentially confined to four hypotheses, of which the principal one used a lock-and-key analogy. The argument is simple; it is important for individuals to mate with the right species, otherwise they waste their sexual substance—and so male genitalia are specialized to key into the complementary female part. This is an intriguing, not to say seductive, idea, but Eberhard dismisses it with a wealth of cogent argument. In practice, it turns out that a lot of different keys can fit one lock, and the shape of sex organs does not prevent mistakes. A related theory that the species shape of the male organ allows the female to recognize the right mate is also rejected along with other previous hypotheses.

This sets the stage for Eberhard's introduction of a completely new way of accounting for the differences. Basically, he argues that male organs are subject to selection by female choice. Put simply, this means that any variation in the structure of penises (or equivalent organs) within a species must be perceived in some way by the female, and that she will exert a preference for one kind over another. This preferred kind is passed on to more offspring than are other kinds. The result is the eventual evolutionary dominance of the preferred form. This process will therefore lead to the development of divergent and complex male organs—the observed situation, in fact.

Eberhard's argument for this point of view amounts to a saturation bombing. He unloads example after example and ex-

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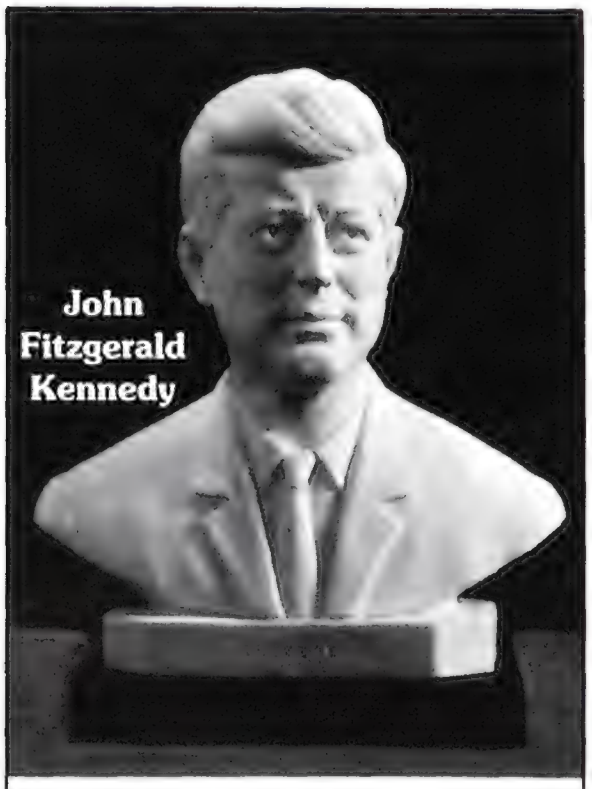
Breaking usual rules, female seahorse puts eggs in male's pouch for fertilization.

plodes contrary argument after contrary argument. It is almost entirely convincing. Some telling points include the fact that when females are inseminated by structures other than those attached to male genital openings, the latter do not vary but the subsidiary structures do. Thus male spiders copulate by using sperm-injecting structures on their heads, and scorpions leave sperm-injecting artifacts on the ground over which they drag the female. In both cases the secondary sex organs are the ones that vary in shape and structure.

The book is full not only of conviction but of interesting bits of information. Many males go to elaborate lengths to protect their inheritance by devices that destroy the sex products of other males, or prevent access to "their" females. My favorite example is the shark that has a "vaginal douche" built into the male sex organ. This may enable one male to wash out previously deposited sperm before he mates with the female concerned.

This is not a book for titillation and it should be read by anyone interested in animals, sex and evolution. It is certainly not too technical for the person with a basic grasp of simple biology. It is written crisply and logically, without hyperbole. For some it may be too crisp and logical, for although it is intellectually stimulating and surely will be influential, it is not exciting in the style of a Desmond Morris or a Stephen Jay Gould. Buy it and try it; it certainly will extend your horizons and enliven your conversations.

Michael H. Robinson
Director, National Zoological Park



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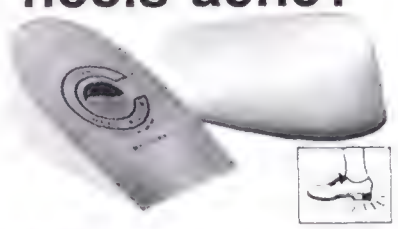

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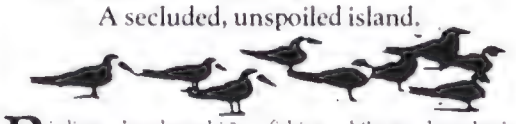

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Lyme disease (p. 131)

"Lyme Disease" by A.C. Steere and S.E. Malawista, *Principles and Practice of Infectious Diseases*, edited by G.L. Mandell, R.G. Douglas jr. and J.E. Bennett (second edition), John Wiley, 1984
"The Spirochetal Etiology of Lyme Disease" by A.C. Steere et al., *New England Journal of Medicine* (Vol. 308), 1983
"Antibiotic Therapy in Lyme Disease" by A.C. Steere et al., *Annals of Internal Medicine* (Vol. 93), 1980

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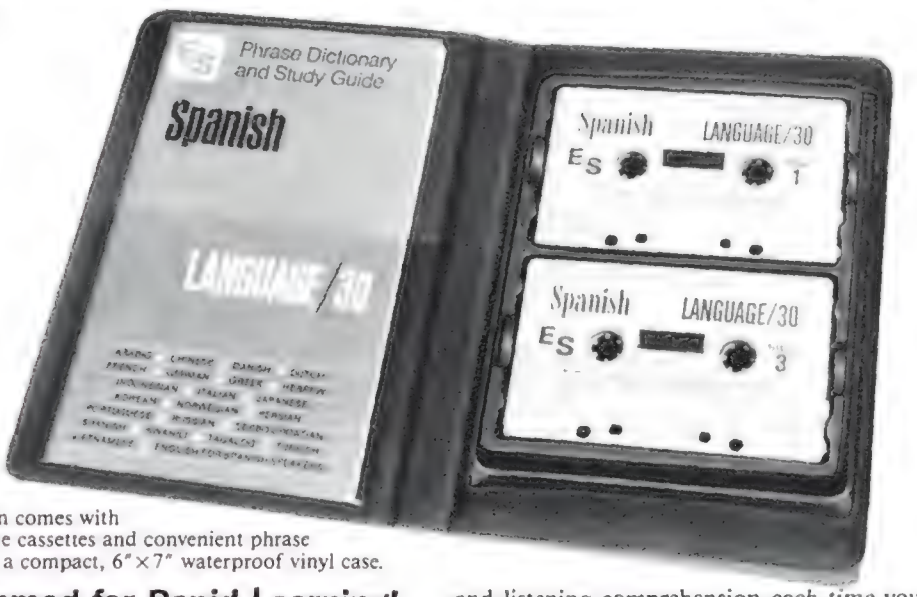

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Smithsonian highlights

On April 18, the three-day-long Washington Craft Show will open at the Departmental Auditorium in Washington, D.C. Sponsored by the Women's Committee of the Smithsonian Associates Program, it will offer for sale the works of 100 artisans from around the country. Baskets, ceramics, fiber, glass, paper (p. 159) and a variety of other media will be included in the show, which emphasizes crafts as fine art. Admission will be $5; $4 for children, senior citizens and Smithsonian Associates. For more information, call 357-4000.

Planning a Smithsonian visit?

The Associates' Planning Packet will help you make the most of your time here. To receive your free packet, write or call: Associates' Reception Center, Smithsonian Institution, Washington, D.C. 20560; (202) 357-2700 or TDD for hearing impaired (202) 357-1729. Begin your visit at the Associates' Reception Desk in the castle, staffed 10 A.M. to 4 P.M. daily; you will receive a cordial welcome, printed materials in a handy bag, and full details about your benefits.

Special April exhibits and events

Freer Gallery of Art
Garden Potteries and Official Kilns: Clan-sponsored Ceramics in the Edo Period (January 17-August 17) See *Highlights continued.*
Wonders of Creation, Oddities of Existence: An Exhibition in Celebration of Halley's Comet (through October 1).

National Air and Space Museum
Wings and Things (April 26 and 27; 10 A.M.-3 P.M.) Aviation open house at the Paul E. Garber Facility in Suitland, Maryland.
Two Who Flew the U-2 (April 24; 7:30 P.M.) Lecture by Col. Art Sabowski (U.S. Air Force) and Martin Knudson (NASA).
Black Holes (April 5; 9:30 A.M.) Monthly sky lecture by Minas Kafatos.

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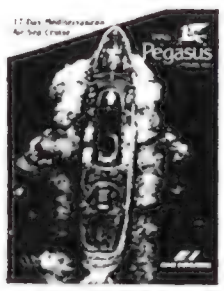

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Michele Tuegel's handmade-paper work, *Welcome Home*, is in Washington Craft Show.

National Museum of American Art
Patrick Ireland: Drawings 1965-1985 (April 4-August 17) Includes 57 drawings and a special installation entitled *Rope Drawing.*

National Museum of American History
Hollywood: Legend and Reality (April 17-June 15) Major exhibition explores history of the American motion picture industry.
Reaching Rural America (April 11-September 22) The history of free rural mail delivery.

Renwick Gallery
The Art of Turned-Wood Bowls (April 17-September 28) Works of 21 artisans.
Frank Lloyd Wright and the Johnson Wax Buildings: Creating a Corporate Cathedral (April 26-September 1) Original drawings, correspondence, models, furniture.

National Portrait Gallery
John Frazee, Sculptor (April 25-August 24) Marble busts, prints, drawings by this largely self-taught American artist.
Imperial Prints: Mathew Brady Portrait Photographs from the Fogg Museum (April 25-August 24).

Cooper-Hewitt Museum (New York)
Bon Voyage! Designs for Travel (April 29-July 13) Historic designs for suitcases, trunks, portable furniture and other travel items.

National Museum of African Art
Bamana Figures (April 30-June 15) Thirty figure sculptures from Mali.

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Hirshhorn Museum & Sculpture Garden
Robert Arneson: A Retrospective (April 30-July 6) Sculptures, drawings, mixed-media works by this irreverent artist.

National Museum of Natural History
On Seeing an Indian for the First Time (April 25; noon) Photographer Victor Masayesva jr. discusses his work among the Hopi people.

Exhibition catalogs

Catalogs available at this time include:
After the Revolution (cloth, $24.95)
Fire and Ice, A History of Comets in Art (paper, $14.95)
Magnificent Voyagers, The U.S. Exploring Expedition 1838-1842 (cloth, $35; paper, $17.50)
Hopi Photographers (paper, $14.95)
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To order, send check or money order to Museum Shops, Box 44083, Washington, D.C. 20026-0083. Include 15 percent of total purchase to cover postage and handling (minimum, $1.75).

Lecture and Seminar Program

This month, the Lecture and Seminar Program will visit Carbondale, Illinois (April 3-7); northern Nevada (April 3-8); Charleston, West Virginia (April 10-13) and Berkshire County, Massachusetts (April 16-20) with programs that highlight current Smithsonian research. The series includes lectures on aviation, art history and anthropology; and seminars on American folk music, volcanology and nature photography. The April programs, which are cosponsored by more than 30 local organizations, are designed to share the Smithsonian's educational resources with Associates, members of the cosponsoring organizations and the American public. Associates in each of these regions should have received invitational brochures by this time. For further information, call (202) 357-1350.

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Radio Smithsonian: 30-minute radio programs on people, places, ideas.
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To find out what stations in your area carry these radio and TV programs, write: Office of Telecommunications, MAH Room BB40, Washington, D.C. 20560.

Resident Associate events

To become a Resident Associate, or to find out about the many other activities presented monthly, or for fee and ticket information, call 357-3030. Here are some April events:

Emerson String Quartet (April 5, 7 P.M.; April 6, 6 P.M.) Haydn, Mozart and Schubert quartets performed in the Renwick Gallery's opulent Grand Salon.

The Best of Gilbert & Sullivan with Stars of the D'Oyly Carte Opera (April 6; 3:30 P.M. and 6:30 P.M.) Concert.

The Genius of François Boucher (April 7; 8 P.M.) Slide lecture by Alastair Laing.

Words and Music in the Poetry of W.B. Yeats (April 13; 7:30 P.M.) Michael Yeats reads selections from his father's works with his wife, harpist Grainne Yeats, providing musical support.

Saga of the Sultans (April 19) All-day seminar on Ottoman Empire life.

Dancers of the Silver Screen (April 20; 3 P.M.) Philadelphia Tap Dancers.

Frank Lloyd Wright: Architectural Milestones (April 26) All-day seminar features major scholars and architectural historians discussing Wright's work.

Smithsonian Institution Traveling Exhibition Service

SITES circulates exhibitions to hundreds of cities outside Washington. To sponsor a show in your community, write SITES, Smithsonian Institution, Washington, D.C. 20560. Some April exhibitions:

Chicago (April 26-August 17) *Mouton Rothschild: Paintings for the Labels*, Spertus Museum.

Davenport, Iowa (April 26-May 25) *Twenty-five Years of Manned Space Exploration*, Putnam Museum.

Elmira, New York (April 19-October 12) *Mark Twain and Huck Finn: Joy-Flags and Milestones*, Arnot Art Museum.

Little Rock, Arkansas (April 19-May 25) *Genre Scenes: Works on Paper from the Hirshhorn Museum & Sculpture Garden*, Arkansas Arts Center.

Los Angeles (April 12-May 18) *Early Flight: 1900-1911*, Museum of Science and Industry.

Wisconsin Rapids, Wisconsin (April 26-May 25) *Baseball Immortals: The Photographs of Charles Martin Conlon, 1905-1935*, McMillan Memorial Library.

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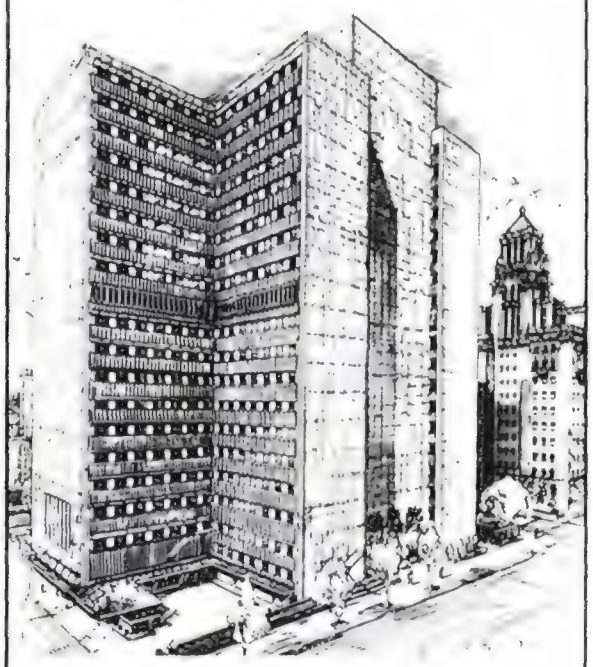
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Daimyo's choice at the Freer

True to the portrayals in recent popular books and movies, the 16th century in Japan was characterized largely by troops rushing headlong from one lord's castle to another's. But in 1603, order was finally established by the shogun in Edo. Three peaceful centuries known as the Edo Period followed, during which esthetic and other cultural rivalries replaced the age of the warlord.

Approximately 260 lords, or daimyo, were scattered about the realm, each answerable only to the shogun. A daimyo was required to live in Edo during alternate years, and his wife and children lived there permanently. All those rituals of coming and going kept the daimyo out of trouble, but it created a huge demand for gifts.

One solution was the sponsorship by many daimyo of an "official kiln," where the finest potters made special wares for use as gifts on ceremonial occasions. Some daimyo also had personal "garden kilns," overseen by professional potters, where their families and guests could make amateur tea ware. At the Freer Gallery of Art, curator Louise Cort has organized 38 pieces into the first U.S. exhibition of these specialized ceramics, and as the exquisite variety of works attests, no daimyo wanted the wares from his kiln to look second-rate—or too similar in style to those of his rivals' kilns. The show will run through August 17.

Constance Bond

Tea-ceremony water jar was made at the Nagoya Castle garden kiln.

Master potter Kita Rihei made cake dish in Takamatsu for Matsudaira clan.

Superb Nabeshima dish has cobalt underglaze, rust and celadon glazes.

Early Nabeshima piece was made when the official kiln was still evolving style.

Trained hand at Iso villa made Satsuma water jar with overglaze-enamel decoration.

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The Hopi and Navajo May 17-27: Visit Grand Canyon, Monument Valley, Canyon de Chelly for an in-depth look at Southwest Indian cultures.

Bermuda June 2-9: Reside at Biological Research Station while exploring island's diverse habitats.

Chicago June 4-8: Walking tours and special programs to study the city's stunning architectural legacies.

Williamsburg for Families June 25-29: Parents and children 7-14 participate in Colonial activities.

Montreal/Quebec June 28-July 7: Experience the charm and hospitality of France in the New World.

Grand Canyon July 11-20: Raft with expert boatmen through magnificent landscape.

Waterton-Glacier International Peace Park July 11-22 or July 25-August 5: Experienced hikers tour backcountry with guides.

Oregon July 11-28: Fresh sea air, mountain vistas highlight this outdoor adventure.

The Black Hills July 26-August 2: Explore Indian culture and cowboy lore in the splendor of South Dakota's Badlands.

Green River Journey July 30-August 8 or August 28-September 7: Experience the thrill of white water, Utah's canyonlands.

Middle Fork August 5-13: An unforgettable river trip on Idaho's Salmon River.

Colorado Mining and Railroads August 8-16: Relive the Gold Rush days when steam locomotion opened the West.

Crow Canyon Archaeology August 24-31: Join archaeologists near Mesa Verde, Colorado, to participate in a dig.

Bryce, Zion and the North Rim September 1-10: Hike canyon trails examining foliage, wildlife and geological history.

Delta Queen September 11-19: Steamboat adventure from Cincinnati to St. Louis along Ohio, Tennessee, Cumberland rivers.

Treasure Houses of Early America September 20-27: Private tours of Winterthur, historic homes, museums around Wilmington.

Maine September 20-28: Hike rocky coast, inland mountains with naturalist.

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Roundabout Italy May 6-23: Relaxed sailing from Venice to Genoa; includes a stay at the palatial Villa d'Este on Lake Como.

Springtime in Sicily May 9-22: Delight in an island harboring monuments from classical Greece to Baroque periods.

London and the English Countryside May 11-25: Exciting city program, travel to country homes, gardens and historic sites.

Spring in Norway May 19-June 1: See International Festival performances by musicians in Bergen. Then on to Oslo.

Danube Journey May 20-June 7: Explore castles, cathedrals and museums from Bucharest to Vienna.

Florence Seminar May 30-June 15: Stay in a villa and study the Renaissance.

Paris to Beijing by Train May 30-July 4: Join adventurous fellow Associates for an experience of a lifetime.

Irish Walk June 2-14 or September 5-17: Take day hikes through a variety of settings in the Ring of Kerry and Connemara.

Wild Highlands of Scotland June 5-23: Enjoy the outdoors while studying about this area's cultural and natural history.

Europe by Train June 11-30 or August 13-September 1: Luxury and splendid vistas on *Orient Express*, Switzerland's *Glacier Express*, France's swift *TGV*.

Island World of Britain June 15-July 3: A circumnavigation to explore ancient ruins, great houses and remote hamlets.

Perspectives on Mediterranean Civilization June 22-July 6: Gain new insights into history, art, architecture in Italy, France, Spain, Morocco and Portugal.

Volga Cruise August 19-September 19: Activities in Moscow, Leningrad, Georgia precede nine-day cruise to historic cities.

Countryside Programs From June to September: Explore scenic and historic areas in Switzerland, Austria, Italy or England.

Write National Associates, Capital Gallery 455, Smithsonian Institution, Washington, DC 20560 or call (202) 287-3362 for tour brochures

in Washington

Smithsonian Seminars at Appalachian State University

June 25-28, 1986

Smithsonian seminars will travel south this summer for a series of four-day programs at Appalachian State University. Located in the beautiful Blue Ridge Mountains of northwestern North Carolina, the University enjoys a delightful summer climate. The seminars are especially designed to take full advantage of the natural and cultural heritage of the Southern Appalachian region. Expand your educational horizons as you join fellow Associates for stimulating seminars on American art, creative writing and fossil identification.

The New Eden: A Century of American Art

Art historian William Kloss shares new perspectives on 19th-century American art as he traces the development of painting from the rapturous works of the Hudson River School through the Luminists to regional landscape art as esthetic expressions of American optimism. Visit the Hickory Museum of Art and the Reynolda House Museum of American Art to view splendid American painting from this period.

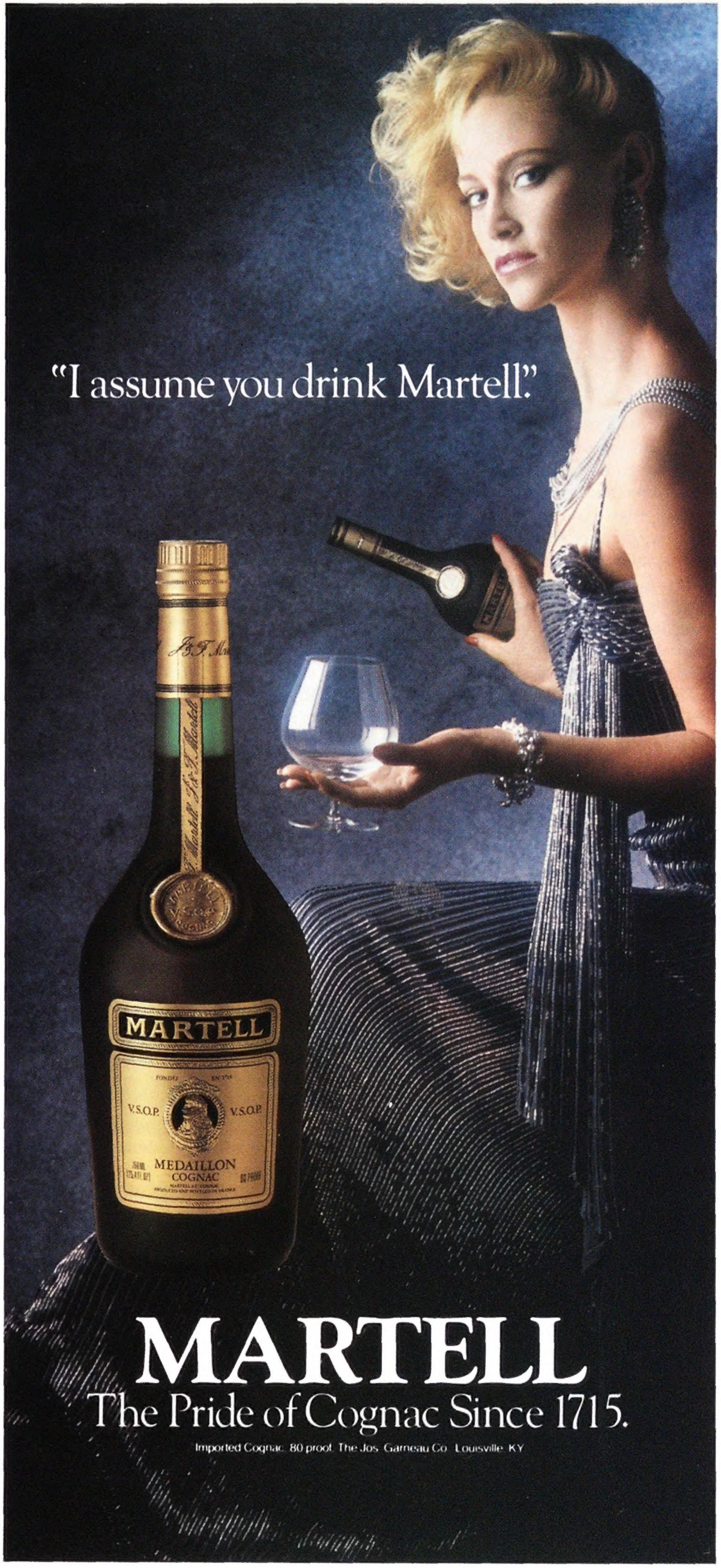
The Art and Craft of Creative Writing

Study the successful techniques of creative writing with Edwards Park, author of SMITHSONIAN's monthly column "Around the Mall and beyond." Learn how to establish a novel point of view and discover how to appeal to the senses through artfully chosen words and images. Explore North Carolina's literary heritage with visits to Connemara (Carl Sandburg's home in historic Flat Rock) and the Thomas Wolfe Memorial in Asheville.

Identifying Fossils

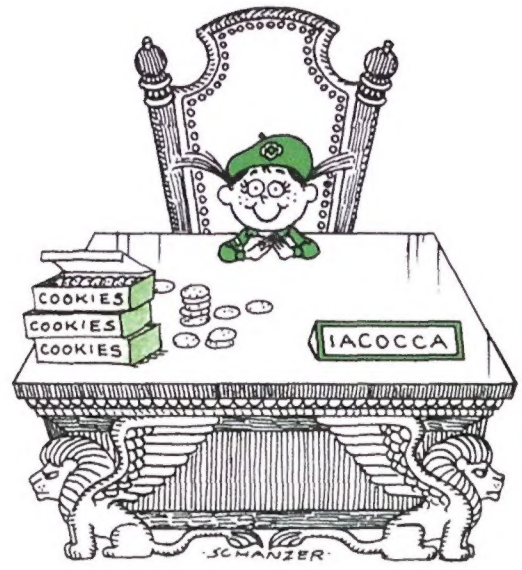
Appalachian State University is surrounded by mountains which some scientists believe to be among the world's oldest rock formations. Explore this region with paleontologist John Hanley and University faculty members during lectures, hands-on workshops with fossil specimens and a field trip to local areas of geological interest where you will see striking fossil and structural evidence of the crucial events that shaped our continent.

or (202) 357-1350 for seminar brochures.



By Richard Wolkomir

'Push those cookies, girls, and look people in the eye'



Dear Mr. Iacocca:

I'm sure you and your fellow captains, admirals and commodores of industry want American business to retain its competitive edge. And that's why I'm suggesting new role models for corporations—the Girl Scouts.

Yes, I understand, Mr. Iacocca. Your game is manufacturing and selling, not tying knots, campfire singing and earning merit badges. But if that is your entire idea of the Girl Scouts, clearly no green-uniformed nine-year-old has worked your office with a cookie-order sheet and a smile, sweet-talking you into a box or two of chocolate mint (the most popular flavor), shortbread, or peanut butter sandwich (my personal favorite) and your diet be darned.

We're talking dynamite selling here. When the cookie legions strike they can devastate entire offices, leaving chocolate-stuffed staffs glassy-eyed and lolling in their wake. Look at the bottom line: $225,000,000 in 1984, gross. That is more than 130 million boxes of Girl Scout cookies. We're talking 13 Girl Scout cookies for every man, woman and child in the United States of America!

Girl Scout business acumen began with the organization's founder 74 years ago. Juliette Low was a formidable Savannah, Georgia, socialite. Her husband, an English rake, died in 1906, leaving her wealthy but unsure what to do with her considerable energies. Then she met Sir Robert Baden-Powell, founder of the Boy Scouts, and immediately began organizing poor girls in the Scottish village near where she was staying at her estate. To save them from having to work in distant factories, she taught her troop to raise chickens, presumably for sale to rich visiting hunters. When that venture proved successful, she promptly taught the girls to spin wool and knit, whereupon she set up markets for their products in London.

Then Juliette sailed back to Georgia and set to work. Like so many forceful executives, Mrs. Low had her peculiarities. She once went trout fishing with Rudyard Kipling in full evening dress, and at a Scout board meeting she stood on her head to exhibit the newly designed Girl Scout shoe she was wearing.

Local toops began baking cookies for sale in the 1920s. By 1938 they were hustling so many boxes that the Scouts turned to commercial bakeries for production. That go-get-'em attitude seems to have its roots in the first Girl Scout handbook, *How Girls Can Help Their Country.*

Scouts were to "Observe Details of People," thus forming "estimates of their character and disposition by their look and clothes." Meanwhile, the Scouts would be ready to handle sales resistance. They practiced archery ("it makes no noise, does not disturb game or warn the enemy"). The handbook recommended shooting, too, as "one of the best ways to 'Be Prepared.' "

So far no recalcitrant cookie customer has turned up with an arrow through his biceps, but cookie sales have generated millions for campsite maintenance, troop gear and service projects. As television financial pundit Louis Rukeyser once pointed out, Scout cookie peddlers outnumber Avon ladies two to one, a million honest, fair, helpful, friendly, considerate, cheerful and respectful go-getters, trained in the art called "Observe Details of People."

Scouts also are ace promoters. A Des Moines council made a stagecoach out of cookie boxes and got a top local radio emcee to broadcast from inside. St. Louis Scouts, thinking big, appointed an elephant named Carolyn, from the city zoo, an honorary Girl Scout. As Rukeyser noted, she "sold cookies by the trunkful."

The Scouts also have a knack for turning parents into volunteer stock clerks: "I volunteered to be a cookie chairman, which turned out to mean boxes and boxes and boxes of cookies in your garage," says Betty Pilsbury, now the Girl Scout national president.

I asked an executive, Sandra, how she handled cookie sales when she was a Scout, 30 years ago. Her eyes turned shrewd. "We lived over an A&P and I set up my table in front of the grocery store's entrance," she told me. "To get in or out, customers had to pass me in my uniform, with my cookie-order sheets."

A 12-year-old Scout I know, Annie, masterfully wields what wheelers and dealers call "leverage": she uses her father's office as a cookie-selling power base. Underlings visiting it come eye-to-eye with Annie and her cookie-order sheet.

One demon cookie seller, New York City Scout Markita Andrews, by age 11 had sold 11,972 boxes. Walt Disney made a film about her, *The Cookie Kid,* which nearly 100 corporations, from IBM to Xerox, have used to motivate their own salespeople. "When you are tired," said Markita, "you can't quit. You have to keep trying."

Girl Scouts, of course, can't offer low interest rates, 50,000-mile guarantees, rental with option to buy, Mr. Iacocca. And they have curious restrictions unknown in the auto industry. Consider Elizabeth Brinton, 14, of suburban Washington, D.C., who in 1985 alone sold 11,200 boxes. This year, at a White House ceremony, she talked the President into ordering seven boxes but had to jump her cookie-selling season's official start by one day. A storm of complaints from other Scouts' mothers hit Girl Scout headquarters. Elizabeth was not abashed: "I feel this is perfectly all right if he's the President."

When today's Girl Scouts eventually take over the executive suites, U.S. industry will be in good competitive hands. As Elizabeth Brinton told a reporter, at her cookie post by a Washington Metro stop: "The secret is to push, push, push—you have to hawk. You really have to push the cookies a lot. And look the people in the eye!"

The dawn of a national treasure.

As the sun comes up on the Statue of Liberty's hundredth birthday, America honors this great lady by minting United States Liberty Coins.

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